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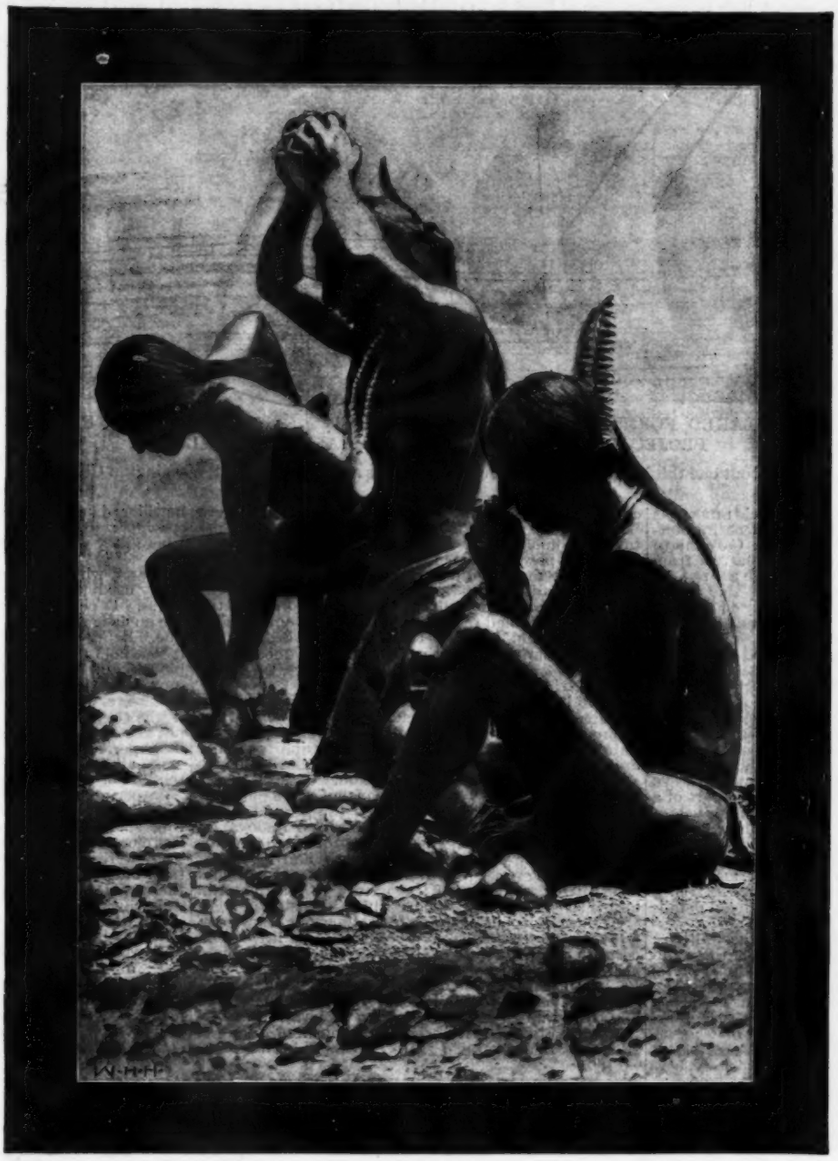
THE MANUFACTURE OF ABORIGINAL STONE IMPLEMENTS.

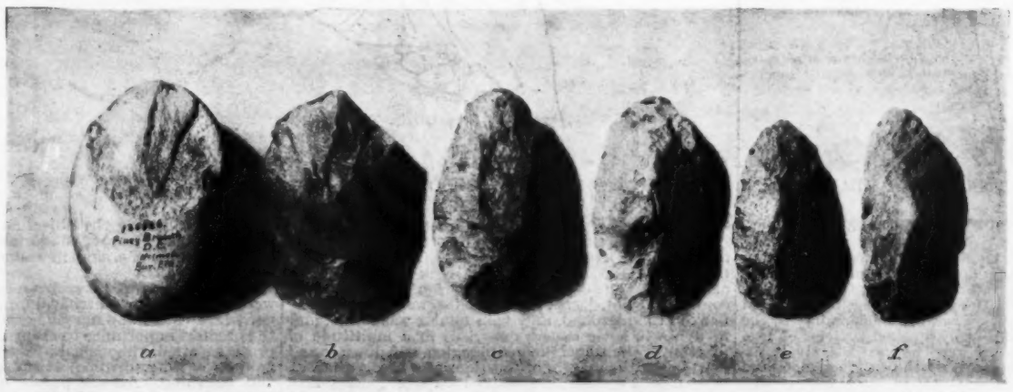
THE origin of a primitive industry is usually shrouded in obscurity, and the narration of the attempts to gather the scattered fragments and build up a picture of early industry is interesting not only to the archæologist, but to the general reader as well. In the Fifteenth Annual Report of the Bureau of Ethnology to the secretary of the Smithsonian Institution, 1893-94, is a most interesting paper on "Stone Implements of the Potomac-Chesapeake Tidewater Province," by William Henry Holmes. Through the courtesy of the director of the Bureau of Ethnology, we are enabled to present a few of the interesting engravings with which the paper is so well illustrated. As the original monograph occupies some 150 pages, all of the details of the explorations will have to be omitted and we shall confine ourselves only to the general conclusions which are adduced.

The Indian tribes inhabiting the great province drained by the tidewater tributaries of the Chesapeake were simple fishermen, hunters and warriors, whose art aimed little beyond the supply of passing needs, and the district now furnishes almost nothing in the way of art remains to attract the popular eye. Little has been preserved beyond the simplest varieties of stone implements; but inconspicuous and elementary as these objects are, they have attracted much attention on the part of archæologists and are now eagerly studied because of their bearing, not only on the history of the region and its people, but on questions of general import in the history of primitive progress. The explorations and studies recorded in the exhaustive paper we have referred to above were for the purpose of determining, if possible, the precise status of these remains, thus making them safely available to the historian of the race, who seeks first of all a safe basis on which to found his structure. The most extensive deposits of the rudely flaked stones were found along the bluffs in and about the city of Washington. The careful investigation so fully recorded in the monograph named above has proved beyond a shadow of doubt that the great deposits are on the sites of workshops connected with extensive quarries where the raw material (cretaceous bowlders) was obtained. It was further found that the widely scattered specimens of the same class were on sites (village sites or otherwise) yielding less plentiful supplies of the available raw material where manufacture had been conducted on a smaller scale. That the vast body of the rudely flaked stones of the province are rejects of manufacture was readily shown.



GROUP IN PLASTER, ILLUSTRATING THE WORK CARRIED ON IN AN ABORIGINAL QUARRY WORKSHOP.

Prepared by Mr. W. H. Holmes, for the World's Columbian Exposition at Chicago.



SERIES OF FLAKED FORMS ILLUSTRATING PROGRESSIVE STEPS IN THE MANUFACTURE OF PROJECTILE POINTS, ETC., FROM QUARTZITE BOWLDERS.

About one-third actual size. Obtained from shops and villages about Washington City.

As a second step in the investigation it was deemed necessary to determine the exact relation of these objects with the real implements of the region. This was accomplished by first determining, by most careful studies of the rejectage of the great flaking shops, just what the product of the flaking operations was. This product, so far as the progress of specialization of form on the shop sites indicates, was found to be a leaf-shaped blade. A third step in these explorations was then undertaken for the purpose of determining the destiny of these blades—where they were carried and how and by whom used. Many specimens of identical form were found on Indian village sites in all parts of the surrounding region and in several cases on sites of historic Algonquian settlements, where they were intimately intermingled with the midden refuse, pottery, and neolithic implements. It was further discovered that a large percentage of the countless stone implements—knives, spearheads, arrowpoints, etc.—found in the broad valley below were of leaf-shaped genesis; that before they received their final shapes by trimming, stemming, and notching, they had been blades corresponding exactly with those produced in a multitude of shops. The shops are, therefore, a necessary complement of the implements of the region, and the implements a necessary complement of the shops. The shops, great and small, are thus definitely connected with the great body of implements of the region, and these implements are directly connected with the dwelling sites of the historic peoples. The practical unity of the stone art of the region is in this way fully established, no type of implement or shaped stone not being fully accounted for by the well established facts and necessary conditions of recent Indian occupancy.

That these demonstrations should be complete and satisfactory, studies were made of quarries of other materials in the neighboring highland where the conditions proved to be the same in every respect. Similar leaf-shaped blades were made and carried out to the surrounding valleys, where they and the implements specialized from them are found closely associated with the more local art products.

It must be regarded as a striking circumstance that a large part of the varied phenomena considered in the monograph are assembled within two or three miles of the capital of the nation, much of it being within the capital city or within the area over which the city streets are now laid out. The greatest aboriginal bowlder quarry known, and the most important implement shops yet observed on the Atlantic slope, are located on Fourteenth Street, two and one-half miles from the Execu

tive Mansion. Until recently it was hardly suspected that the Potomac-Chesapeake province was so rich in ancient remains. The arts and industries of the historic aborigines were extremely simple, and no striking monument or remains of any kind are found to tell of vanished peoples. Careful exploration has, however, developed evidences of an intelligence and enterprise hardly to be expected of tribes of indolent savages. The use of stone by the prehistoric aborigines was limited to the manufacture of implements and utensils, but their knowledge of the mineral resources of the region was so extensive that no deposit of bowlders, no ledge of flakable stone, no deposit of available stone of any kind, seems to have escaped their attention. Quarrying and manufacture were extensive, and the distribution of the product extended in several cases for a hundred miles or more beyond the source of supply.

The historic tribes of the region are mainly of the Algonquian linguistic stock, the stock of Powhatan and King Philip, and this notable people may be connected by means of the art remains of their numerous village sites with the great body of ancient inhabitants whose domain extended from South Carolina to Nova Scotia. There are some traces of departure from ordinary Algonquian types of art, but these are not decided enough to warrant the assumption that other peoples of independent culture were directly concerned. The culture status indicated by the remains here brought to the attention of students is precisely that of the historic inhabitants encountered by John Smith.

The explorations embodied in this monograph began in 1889 and continued with much interruption until 1894. It is evident from this that the field has been imperfectly covered, for the tide water Chesapeake country comprises upward of 20,000 square miles of territory, nearly every mile of which abounds in important traces of ancient aboriginal occupancy. To visit all and examine all would require a good part of a lifetime. Realizing this, the method was adopted of passing rapidly over the various sections and selecting a few typical examples of each class of sites or groups of phenomena for minute examination. The detailed studies made of these sites serve in a great measure to illustrate the whole subject, and though imperfect in many ways, form nuclei about which additional details can be assembled as they are acquired.

Stone exists in many varieties, forms, and conditions, which differ greatly in the various sections of the country, thus giving much diversity to the manner of its utilization and to the forms employed in art, and many local peculiarities of art phenomena have arisen. Moreover, the tribes of this region were not fully sedentary, and the materials acquired in one section were carried into another, giving rise to much variety in the materials employed by a single people or assembled in a given place. This complexity was also increased to some extent by trade, and no doubt by the undertaking of long journeys for the purpose of securing desired materials. Transportation was confined mainly to the smaller and more laboriously finished articles of use. Unshaped raw materials were not extensively transported, and the large body of the heavier tools and utensils made where material was plentiful were deserted when the locality was abandoned.

The great rivers of Mesozoic and Cenozoic times swept down from the highlands, bearing fragments of all varieties of rocks and depositing them in beds along the margin of the sea. These transported fragments were, when first taken up by the water, sharp and rugged, but by constant rolling they were reduced to rounded forms, and included all sizes from grains of sand and minute pebbles to bowlders and even to great masses. All classes of rocks were thus seized by the floods and carried seaward; but all varieties did not reach the sea, save perhaps as sand or clay. The softer rocks were reduced to powder before the journey was fairly begun; brittle and much flawed varieties, and all friable shales and slates, separated into minute fragments and formed beds of sand and gravel; the tough, hard, homogeneous pieces were rolled and rounded and carried ever onward, refusing to break or to be reduced to dust, and finally rested along the seashore and more especially about the mouths of the great rivers.

The primitive inhabitants of the crystalline highland had to make use of massive forms of rock or of rude angular or slightly waterworn fragments, and the reduction of these to available sizes and forms was a difficult work. But the inhabitants of the lowlands were born to more fortunate conditions. The agents of nature—the floods—had, with more than human intelligence and power, selected the choice bits of rock—the tough quartzite, the flinty quartz, the tough and brittle lavas, the indurated slates, the polished jasper and the beautiful flints—from all the cliffs and gorges of the mountains and had reduced them to convenient sizes and shapes and had laid them down in beds of the shallow estuaries, where, through the subsequent rising of the land and the cutting of the valleys, they were found at the door of the tidewater lodge.

It will be readily seen that these conditions of mineral resources must have had a marked effect on the art of the region and thus on the culture of the natives inhabiting it. One drainage area supplies quartz mainly and the art is quartz art; another supplies quartzite and the art is quartzite art, and so on.

Quarrying begins with the removal of a fragment or mass of material partially buried in the ground. It is but a step further to the uncovering and removal of portions wholly buried, and only another step to quarrying on a large scale. The methods and extent of the quarrying necessarily differed with the peoples and their circumstances, with the nature of the material and with the conditions under which it existed.

Of the details of quarrying operations our knowledge is yet imperfect, though much has been learned in certain directions; and of the tools used in quarrying, aside from those made of stone and left on the sites, no definite information has as yet been obtained. It is quite likely that implements of wood, buckhorn, and bone were used, as in foreign stone age quarries, but traces of these have wholly disappeared from the sites thus far examined. Fire may have been used in some localities as an agent in fracturing masses of stone, but the tidewater region furnished little material, save perhaps quartz, suitable for manipulation by this means. Massive forms of rock are found west of the fall line or western border of the tidewater country. Flint, jasper and rhyolite were quarried far back in the highland, and vein quartz was found, and no doubt to some extent quarried, in a multitude of places over the whole Piedmont region, and down to and even below the margin of the tidewater area. Steatite or soapstone is a tough, massive rock interbedded with gneissic formations, and rarely occurs in detached masses. In the beginning of its use it was secured where exposed on the surface by prying off small masses. The lumps thus secured were ready for the sculptor's chisel. In time quarrying developed and was extensively carried on in many parts of Virginia and Maryland beyond the tidewater border.

The surface or float cobbles were extensively used, but the aborigines came to need more than could thus be obtained, and resorted to digging them from their places in the bluffs. The implement makers seem to have found that the freshly removed stones were more easily worked than surface finds, and quarrying, thus encouraged, was carried, in at least two places, over acres of ground. The bowlders were not always easily loosened and removed, as the rounded stones were held together by a matrix of sand and clay which had assumed the consistency of a sandstone; but the miners did not always penetrate the formation from above or even directly from the face of the outcrop. It happened that in many cases the bowlder beds rested on a surface of disintegrated gneiss exposed in bluff slopes, and by removing the upper surface of this with such pikes as were at hand the bowlders were undermined and easily knocked down. So far as observed, the bowlder deposits containing workable stone in any considerable quantity rest on the gneissic surfaces where they were laid down by the waters of the ancient sea.

Quartz, which was more generally if not more extensively used than any other material, is found in two forms. It occurs in countless veins which penetrate the gneissic rocks over a large district west of the fall line. Being much less destructible than the gneisses, it weathers out in dikelike ridges and breaks up into blocks and angular pieces which spread over the ground in vast numbers. Choice varieties of this vein rock were, without doubt, quarried to some extent, but it was so plentiful on the surface that quarrying was not generally necessary. Carried down by the streams of all periods, it occurs plentifully as pebbles and bowlders in all formations in the watertide region, and was selected or quarried along with the quartzite.

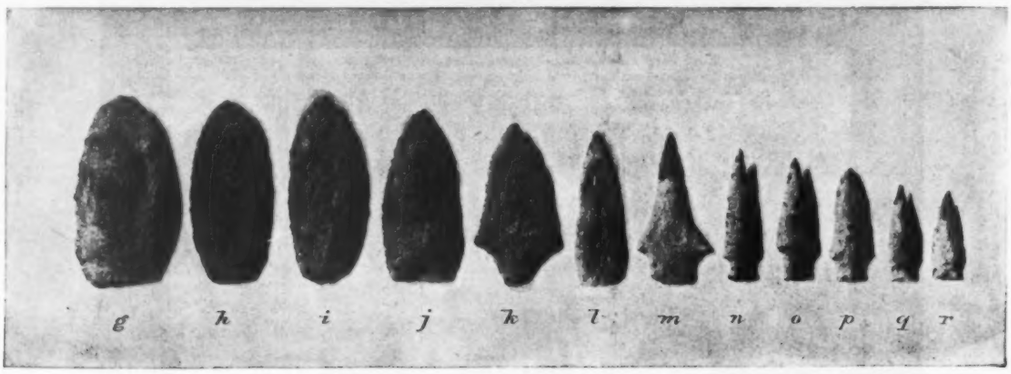
Jasper, flint, rhyolite and other varieties of stone were rather rare within the tidewater districts, occurring sparingly as pebbles, small bowlders and worn fragments in gravel deposits and in the beds of rivers. They were procured, however, by the tidewater tribes from masses in place in the uplands and mountains, the quarries being quite extensive.

Having secured the raw materials from the surface or by quarrying, the next step was either to utilize them unchanged or to shape them for use.

Sharp-edged and pointed stones were used for cutting, digging, etc., and rounded cobbles from the river or from gravel beds were well suited for striking, pounding, grinding, etc. But with these unmodified forms we have little to do, as it is not easy to say that any given specimen was used at all, unless it bears decided marks of use; and decided marks of use may be regarded as giving the object an artificial form, as in the case of the improvised mortars, mullers and hammer stones so common in the Chesapeake-Potomac region.

The shaping processes, by means of which stones were made to assume artificial forms adapted to human needs, are varied and ingenious, and their mastery is of the greatest importance to all primitive peoples. These processes are distinguished by such terms as breaking, flaking, cutting, drilling, scraping, pecking, grinding and polishing. All are purely mechanical; none are chemical, save a possible use of fire to induce changes in the rock in some parts of the quarry work.

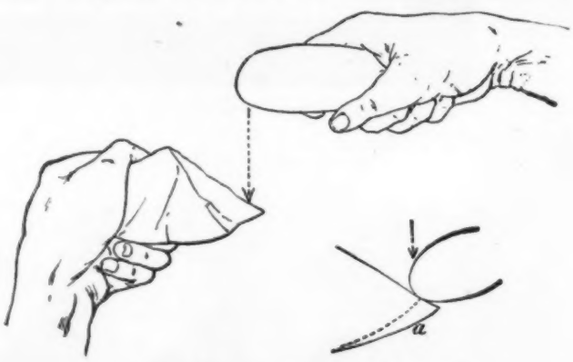
The wide range of manual operations is represented, and these may be conveniently arranged in four



SERIES OF FLAKED FORMS ILLUSTRATING PROGRESSIVE STEPS IN THE MANUFACTURE OF PROJECTILE POINTS, ETC., FROM QUARTZITE BOWLDERS.

About one-third actual size. Obtained from shops and villages about Washington City.

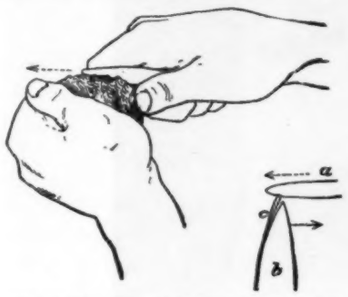
FIRST STEP IN BOWLDER FLAKING.



SECOND STEP IN BOWLDER FLAKING.

groups: 1, fracturing, represented by the terms breaking, flaking, and chipping; 2, incising, including cutting, picking, and scraping; 3, battering, including such acts as bruising, pecking, and hammering; 4, abrading, as in rubbing, drilling, boring, sawing, and polishing. These acts are employed according to the nature of the stone or the results desired; as for example, fracture is employed where the stone to be shaped is brittle, like flint, jasper or quartz; incision is employed where the stone is relatively soft, such as soapstone, serpentine and the like; battering is applied to tough materials, capable of resisting the shocks of percussion, like granite rocks and many of the eruptives. Nearly all varieties are capable of being shaped by grinding and rubbing.

The processes employed in a given piece were determined by the nature of the material, by the intelligence and skill of the workman, by the character of the subject designed, and by a number of minor considerations. Ninety per cent. of the stone implements produced in the tidewater country were shaped by the

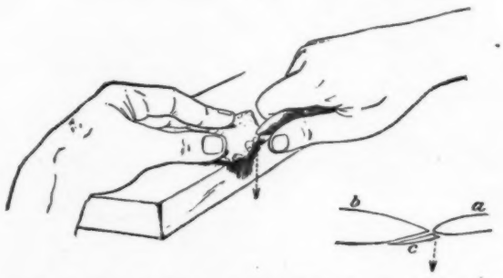


FLAKING BY PRESSURE, A BONE IMPLEMENT BEING USED.

a, the bone tool; b, the stone; c, the flake.

fracture process. For convenience of treatment the subject is divided into three sections, which have been noted above. The fourth or abrading process being mainly auxiliary to the others. We will now take up the consideration of fracturing or flaking. The art of flaking stones was extensively practiced in the tidewater region, where ample opportunity is afforded for observing the work in all its stages. The first step in the process, where masses were dealt with, consisted in breaking the material by heavy blows into somewhat approximate shapes and sizes; the second step was roughing out by freehand percussion the blank forms of the various classes of tools desired. The third step was the specialization of forms by direct or indirect percussion or by pressure. It was found convenient and profitable for certain individuals to give exclusive attention to the separate steps—first, quarrying, breaking up the material and selecting pieces in large numbers; second, to roughing out the blank forms and numbers; and third, to the work of trimming, specializing, and finishing. These three well defined steps gave rise to a separate industry, carried on by the same individuals at different times or stages or by distinct groups of experts at convenient times and places. It would seem that the first and second steps, whether performed by one or two groups of workmen, were generally accomplished on the spot yielding the raw material; it would be unprofitable to transport masses of material of which nine-tenths would finally have to be consigned to the refuse heap. The blank forms of the articles to be shaped, worked out so far as thoroughly to test the material and its capacity for specialization, were removed from the source of supply to be finished when convenient or when need demanded.

Where disseminated materials were utilized, and especially in cases of immediate need, all the steps were frequently taken and the perfect implement produced at once; but it is observed that in many cases where the material was sparsely scattered as bowlders or nodules over the face of the country, the work of collection and blocking out was first attended to and the hoards of blanks thus produced were transported and stored, subject to final distribution for specialization or use.



FLAKING BY PRESSURE, A BONE POINT BEING USED, THE IMPLEMENT TO BE SHAPED RESTING ON A SUPPORT.

As has been indicated, flaking was employed almost exclusively in the production of projectile points, knives, scrapers, perforators (or drills), hand axes or choppers, notch axes, hoes and picks; it serves to aid in roughing out the forms of various articles finished by pecking and grinding; these are mortars, pestles or mullers, axes, celts, chisels, types, ornaments, and diversional and ceremonial objects.

The flaking tools were probably bowlders selected for the purpose from the multitude of available examples; though few were found that show any considerable evidence of wear, many specimens occur which were more or less battered, apparently by use. With multitudes of natural hammers of choice shape and assorted sizes at hand, it was manifestly useless to shape special tools or to bring in shaped tools from the outside.

The first step after the removal of the bowlders from the bed by the quarryman was to test them for quality of material. As a rule, the removal of a single flake, or at most a very few flakes, enabled the expert workman to determine whether or not the stone was reasonably tractable. The selected material was removed to the shop sites, where the flaker took up the work. The process of flaking appears to have been exclusively fracture by free-hand percussion, the act being a quick, firm stroke, regulated in force by the nature of the resistance to be overcome and by the result observed. The bold but unsymmetric outline of the forms produced and the rather haphazard arrangement of the percussion points preclude the idea that any process capable of accurately adjusting the point of contact between the tool used and the article shaped could have been employed. At best such a method would certainly not be readily applicable to a stone of the refractory nature of quartzite. Though the manner of delivering the strokes seemed sufficiently determined, the precise method of holding the stone shaped is left to conjecture. My own experiments, says Mr. Holmes, have been conducted upon the assumption that it was held in the hand. The account of flaking processes given in the following paragraphs is based on the belief that free-hand percussion with hammers of stone or other hard or heavy material was the exclusive or principal quarry shop process.

The process of manufacture and the steps of development were essentially as follows: Grasping a bowlder in either hand, the first movement was to strike the edge of one against that of the other at the proper angle to detach the flake. The second movement and the third were similar, and so on until the circuit was completed. If no false stroke was made and the stone had the right fractures, these few blows, occupying but as many seconds, gave as a result a typical turtleback—a bowlder with one side faceted by artificial flaking, the other side, save through accident, remaining smooth. If the removal of a single row of flakes were not sufficient, the work was continued until the one side was reduced to a proper degree of convexity, and the availability of the stone for further elaboration was made apparent. If the results thus far reached were satisfactory, the stone was turned in the hand, and by a second series of blows the remaining smooth side was flaked away, when the result was a two-faced stone or double turtleback—the incipient blade. With perhaps a few additional strong strokes the rough stone began to assume the appearance of the final form. If at this stage, or if at any preceding stage, the stone developed defects or unmanageable features (such as too great thickness, crookedness, or humps that could not be removed), it was thrown away, and thus became a part of the refuse; and it would appear that all the entire specimens collected, since they were taken by us from the refuse, did develop some of these shortcomings. If, however, the form developed properly, the work was continued into the final stage, which consisted in going over both sides a second and perhaps a third time, securing, by the use of small hammers and by deft and careful blows upon the edges, a thin, symmetric blade.

It is important to observe that when the thin blade was realized, the work of the quarry shop (and the only work of the quarry shop so far as shaping was concerned) was ended. The process and the machinery had accomplished all that was asked of them and all they were capable of accomplishing. The neat, but withal rude, blades, and these only of the shaped products, were carried away. Further work, additional shaping—and such there was in most cases, no doubt—employed other processes and was carried out in other fields. Flakes and fragments suitable for elaboration into implements may have been selected for transportation, but no evidence of this is procurable. The course of procedure just described Mr. Holmes has investigated in the most careful manner, and by experiment has followed every step of the process, and has achieved almost every result. Mr. Holmes found that in reaching one final form many failures were left by the way, and that these failures duplicate, and in proper proportions, all the forms found on the quarry sites. Mr. Holmes was unfortunately prevented from carrying out these experiments as fully as desirable by permanently disabling his left arm in attempting to flake a bowlder of very large size.

Mr. Holmes further found by these experiments—and the conclusion is a most important one—that every implement resembling the final form here described, and every blade-shaped projectile point made from a bowlder or similar bit of rock not already approximate in shape, must pass through the same or nearly the same stages of development, leaving the same wasters, whether shaped to-day, yesterday, or a million years ago; whether in the hands of the civilized, the barbarous or the savage man.

We are not prepared to say at just what point in the shaping of the blade or implement from quartzite and each of the other stones the percussion ceases and the pressure processes take up the work. It is certainly later in the quartzite than in any of the others because of its coarse grain and exceeding toughness and the consequent lack of thin and sharp edges on which the pressure tool must take hold.

In the method most readily available for the final steps a blank form or a flake having the approximate shape was held firmly between the fingers and thumb of the left hand. A firm piece of bone having a rather thin edge or angle like that of a three-cornered file was taken in the right hand and set upon the sharp edge of the stone and at right angles to it so firmly that a slight cut or notch was made in the bone; then, with a quick, firm movement of the right hand, met by a similar movement of the left, the bone was made to move across the edge of the stone, in doing which it took with it a flake, varying in length, width and depth with the skill and power of the workman, the nature of the stone, etc. A rapid repetition of this operation, accompanied by a proper resetting of the tool, quickly reduced the piece if it worked readily to almost any desired outline. The same result was obtained in various other ways, but always by means of suddenly applied or spasmodic pressure. The blank form may have been held down by the fingers on the edge of the stone, as shown in our engraving, and the point of the bone held in the other set so as to catch the edge of the stone to a width corresponding to that caught by the notched bone in the other position, when a quick downward pressure upon the flaking tool would remove the flake. Again, in larger work, where greater force was required to remove the flakes, a tool large enough to place against the arm or chest of the operator may have been used. In this way much additional force could be thrown into the spasmodic movement. Another device, practiced by some tribes, consisted of a notched or forked bone or pincers, which was set upon the sharp edge of the blank and given a sudden twist, thus removing the flake. These operations apply exclusively to implements of leaf blade type and to minute forms of other origin; the various ruder and heavier variety of tools were shaped by percussion exclusively.

The subjects of battered and abraded stone implements and incised or cut stone utensils are also treated in Mr. Holmes' interesting monograph.

Our engravings show the various steps in bowlder flaking and a series of flake forms showing progressive steps in the manufacture of projectile points from quartzite bowlders, and also a group in plaster, illustrating the work carried on in an aboriginal quarry workshop. This quarry group was prepared by Mr. Holmes as an exposition exhibit for the Columbian Exposition in Chicago, 1893. It is intended to exemplify a great art of the race—the shaping of stone by flaking processes. After the return of the group from the Exposition, Mr. Holmes conceived the notion that the figures could be taken to Piney Branch and placed in an actual quarry, thus more graphically portraying the ancient operations. A site was selected for the purpose on the margin of the gulch near Fourteenth Street, Washington, where some great oaks grow on the beds of ancient refuse. But before the project could be carried out, Mr. Holmes was called away from the work permanently. Messrs. Cushing and Dinwiddie, of the Bureau of Ethnology, generously took up the work, and the result is indicated in an interesting review which accompanies this monograph.

ROMAN MEDICINE STAMPS.

IT is somewhat curious that medical specialism and proprietary medicines appear to have had their advent about the same period. That the latter owe their origin to the Roman specialists we have ample proof from the medicine stamps or stones which have been discovered from time to time on the sites of old Roman cities in France, Germany, etc., all of which agree in their general characters. These stones generally consist of small quadrilateral or oblong pieces of a greenish schist or steatite, engraved on one or more of their sides. The inscriptions are in small Roman capitals cut intagliate, and consequently reading on the stone itself from right to left, but making an opposite impression when stamped on any plastic material. The stamps are usually engraved with the names of the medical practitioners to whom they pertained, also the names of some special medicine or medical formula, and the disease for which the medicine is prescribed or recommended, and there can be no doubt that they were employed by the Roman doctors for marking their drugs, a practice apparently carried on at the various stations throughout Europe.

IMPRESSION FROM A CIRCULAR ROMAN MEDICINE STAMP.

Most of the stamps discovered are inscribed with the names of medicines or preparations applicable for affections of the eye, and the diseases, when specified, are invariably of an ophthalmic nature. It is therefore probable that these stamps were used by oculists alone. The Romans employed the term collyria to both solid and liquid applications for the eye. The solid collyria were composed of various ingredients with a base of gum and starch, and wrought to a pasty consistence. They were used in almost every stage of disease of the eye. Some were known by the names of the oculists who invented them, others from their color, or from the

A PERFECT ROMAN MEDICINE STAMP.

name of some great personage whom it may have cured. The stamps were employed to impress the soft substance with the required inscription, and also to stamp the labels (pittacia) attached to the vessels of the liquid collyria. Marcellus, in his work "De Medicamentis," specially praises the collyrium known under the name of "Evodes." He directs it to be dissolved and diluted in water, and introduced into the eyes with a probe.

The stamp of this collyrium has been discovered, and bears the following inscriptions: On one side, "The Evodes of Lucius Vallatinus for Cicatrices and Granulations;" on the other, "The Mild Crocodes of L. Vallatinus for Affections" (of the eyes).

From this it is evident that Vallatinus prepared more than one special application for the eyes.

A stamp found at Bath in 1731 bears the following interesting inscription:

"The Leaden Melinum (or Golden Yellow Collyrium) of T. Junianus for clearness of vision," from which we may infer Junianus sold his "Golden Yellow Collyrium" to the colonists and natives of Bath some 1700 years ago. The popular name "Golden Ointment," given to an application for the eyes, is therefore of greater antiquity than is generally supposed, and it may interest pharmacists to know that it was originated by a Roman oculist.

Two other stamps discovered bear the following inscriptions:

"The Dialepidos or Copper Collyrium of Marcus Julius Satyrus for granulation of the eyelids."

"The Myrrh Collyrium of L. J. Ivenis to be used twice a day mixed with an egg at the commencement of ophthalmy."

Another stamp found at Kinchester in Herefordshire bears the following inscriptions on its sides:

1. "The Anicetum or infallible Collyrium of F. Vindacius Ariovistus."
2. "The Nardinum of Spikenard Collyrium of F. Vindacius Ariovistus."
3. "The Chloron or Green Collyrium of T. F. Vindax Ariovistus."

These are described by Dr. Simpson in the Monthly Medical Journal for 1851. A stamp discovered at Wroxeter in 1808 is inscribed as follows: "The Dialebanum of Tiberius Claudius, the physician, for all complaints of the eyes, to be used with egg." This stamp is now in the Shrewsbury Museum.

The most perfect stamp yet discovered (of which we give an illustration) was found at Tranent, near Edinburgh, and is now in the museum of the Society of Antiquaries of Scotland.

ROMAN OCULIST'S STAMP FOUND AT TRANENT, E. LOTHIAN, N. B.

The Roman practitioners seem to have pursued in regard to old cicatrices of the eye a treatment which is not followed by their successors in modern times, as they used various collyria for the purpose of dyeing or changing the color of these white cicatrices, and thus imparting to them some kind of tint that rendered the appearance of the eye, and the distinction between the transparent cornea and its cicatrices, less marked and striking. For this purpose galls appear to have been largely used.

It is worthy of note that Stolus, the first British medical practitioner mentioned in the pages of medical history, and whom Galen describes as celebris some 1700 years ago, originated the "Cinnabar Collyrium."

Altogether over sixty Roman oculist stamps have been discovered in different parts of Western Europe at various periods, which proves that medical specialism must have flourished in those early times.—Pharmaceutical Journal.

THE FINDING OF THE REMAINS OF THE FOSSIL SLOTH AT BIG BONE CAVE, TENNESSEE, IN 1896.*

THE fossil sloth bones found in Big Bone Cave, Tennessee, illustrate an investigation at one of the points of contact between paleontology and archæology. They explain an effort made during the last several years by the Department of Archæology and Paleontology of the University of Pennsylvania to settle the question of man's antiquity in North America through a study of the association of human with animal remains in caves. Turning away, for a time, from mounds, village sites and buried cities, we have sought the help of the naturalist in a systematic attempt to penetrate the crust of recent earth under foot, to trace man through a mixture of the familiar vestiges of such animals as the deer, the bison, the bear, the beaver, the muskrat and the wolf, still existing in the American forest, and to follow him down into that older world layer next below called the Pleistocene. There we have endeavored to find, if possible, his bones still associated with the remains of the extinct mastodon, the mammoth, the tapir, the giant beaver and the fossil sloth.

Much remains to be done over a wide territory, before the evidence of American caves, for or against man's geological antiquity, can be adequately collected or reasonably summed up. But already, in the territory examined in the eastern United States and Central America, some landmarks seem to have been established in the pre-Columbian darkness.

Here, then, to return to the particular specimens presented by me, are bones which, from the point of view of anthropology, might be presumed to be very ancient, older than the pyramids of Egypt or the oldest inscribed brick yet found in Babylonia, but which, it must be confessed, appear quite modern. I removed them with my own hands out of the floor earth of Big Bone Cave, Van Buren County, Tenn., in last May (1896), while conducting thither an expedition for the Department of American and Prehistoric Archæology of the University of Pennsylvania.* Strange to say, many have articular cartilage clinging to them. Most have been gnawed by small rodents while still retaining their juices, and for these reasons and because, as we shall see later, they form part of a set of bones, doubtless of one and the same animal, obtained from Big Bone Cave first in 1835, next in 1884, and now last by me in 1896, they may be classed as pertaining to the most modern looking if not the most interesting series of remains of the extinct animal ever found in the United States. In this case, since the position and the association of the other specimens alluded to of 1835 and 1884, previously found in the same cave by farmers, were not observed, the bones here shown constitute the only remains of this Big Bone Cave animal, whose relation to surrounding facts bearing upon their age has been studied so as to furnish some reasonable conclusion as to how and when the creature got into the cave, and whether or not it was a contemporary of the Indian in the Southern mountains.

FIG. 1.—BIG BONE CAVE.

In the first place, it should be said that the bones did not come from a human culture layer nor from a den of large carnivora. Neither were they found at a site where the cave explorer would have chosen to dig, but rather at a spot where all the conditions of exploration seemed unfavorable. They were rescued from one of the subterranean galleries at the last moment, after the whole cave had been rifled for saltpeter.

About one mile from the left bank of Caney Fork River, and one mile above the mouth of a confluent called Dry Branch, in Van Buren County, Tenn., probably 1,000 feet above the sea, Big Bone Cave opens from the carboniferous limestone upon the head of the "Beech Cove," one of the secluded ravines called "coves" that furrow the western slope of the Cumberland table land.

To our surprise, the point of interest in Big Bone Cave lay far beyond the reach of daylight. It was only found after turning to the right from the main tunnel and following a small bifurcating passage for 900 feet.

Laden with pickax and shovels, baskets, instruments, candles and provisions, now crouching where the roof lowered, now clambering upon a log across an intersecting crevice, eight or nine feet deep, we followed the lead of Priest, until directly on the footway a spot was reached where, in the utter darkness, beyond the range of the continued haltings of men, and probably from that of animal remains dug out of the rock shelters of Europe, or from that of specimens derived from any layer of caked human rubbish where savages have been wont to take subterranean refuge. Men certainly did not bring them into the cave. Frost had never reached them. Neither would change of temperature have affected them where they appeared to have rested in the dry earth in an unchangeably cool air since the time of their deposition.

Let us describe this place. The roof has expanded over several branching alcoves, partitioned head high by screens of eroded rock. Mysterious crevices in the ceiling rise above us beyond the reach of candle light. There are no stalactites and we feel no trace of dampness. The severe outside heat of the Southern spring has been reduced to a dry and cool subterranean temperature of 55° F. Where a flanking screen narrows the gallery to a width of three and four feet, the earth is soft and mealy under foot and covers the whole floor, rising in a cloud of dust when disturbed by a kick. This floor deposit proves on examination to consist of a noxious and volatile mantle of dry, loose excrements, mixed with vegetable remains, covering up and spoiling by its intermixture the nitrous earth resting in lumps beneath it, and thus sufficiently explaining why, as far as saltpeter digging was concerned, that part of the cave had never been disturbed.

We were directly upon the cave path, where back and forth over the dusty manure all footsteps of all saltpeter hunters, all white men, all Indians, choosing to penetrate deeper into the cave, must needs have passed. Their trampling had draggled the surface, kicking earth into it from other areas, or dropping "peter dirt" upon it from bags. Moreover, charred pieces of resinous pine, Pinus mitis, twigs of hazel, Corylus americana, and fragments of burnt cane, Arundinaria tecta, strewed the surface, representing doubtless the remains of the torches of such white niter hunters as had not had lamps or candles, and, we may reasonably suppose, of the Indians who had preceded them. The appearance of this surface film, then, which I have called

LAYER I

(Two to three inches thick),

thus disturbed for two or three inches, and scattered with lumps of nitrous earth and with these burnt sticks, was sufficient to demonstrate that human beings had visited the cave, if no further proof of the fact had existed. Over and above the certainty that white men had long passed and repassed the spot, and that many of the torch ends, and particularly the pieces of pitch pine (which suggested the splitting agency of iron tools), might be referred to them, it seemed reasonable to suppose that some at least of the pieces of charred cane (resembling fragments of Arundinaria found by us mingled with aboriginal bones in the sepulchral chasm of large animals, at a point where no human culture layer, under ordinary circumstances, could have been formed, these remarkable bones of the sloth and all other sloth bones, known to have been previously removed from the cave, were found. Elsewhere the evidence of the relation of animals and men to the cavern, whatever its character, had been destroyed.

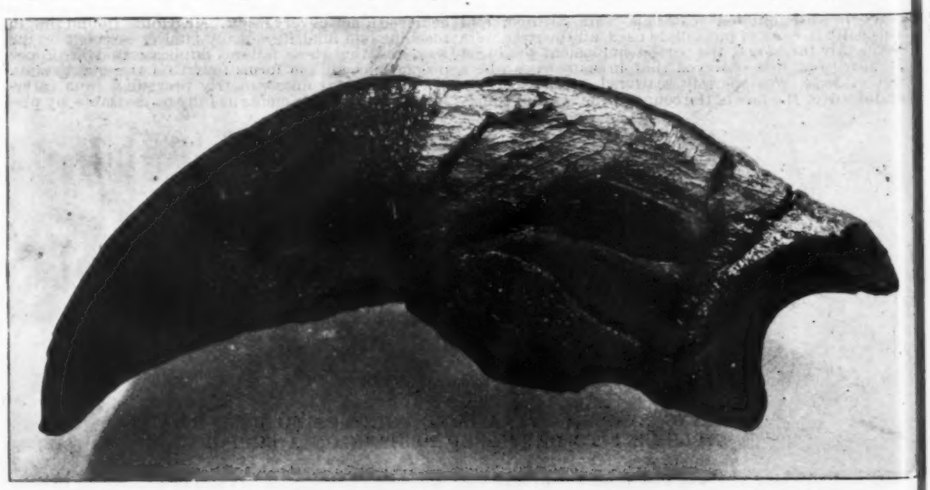


FIG. 2.—CLAW WITH CARTILAGE AND HORNY SHEATH OF THE SLOTH MEGALONYX.

From the J. P. Wetherill collection at the Academy of Natural Sciences of Philadelphia. One of the bones found in Big Bone Cave before 1835, and inferentially a part of the same young animal represented by the other illustrations. Actual size.

The record of these bones is, therefore, very different from that of animal remains dug out of the rock shelters of Europe, or from that of specimens derived from any layer of caked human rubbish where savages have been wont to take subterranean refuge. Men certainly did not bring them into the cave. Frost had never reached them. Neither would change of temperature have affected them where they appeared to have rested in the dry earth in an unchangeably cool air since the time of their deposition.

Let us describe this place. The roof has expanded over several branching alcoves, partitioned head high by screens of eroded rock. Mysterious crevices in the ceiling rise above us beyond the reach of candle light. There are no stalactites and we feel no trace of dampness. The severe outside heat of the Southern spring has been reduced to a dry and cool subterranean temperature of 55° F. Where a flanking screen narrows the gallery to a width of three and four feet, the earth is soft and mealy under foot and covers the whole floor, rising in a cloud of dust when disturbed by a kick. This floor deposit proves on examination to consist of a noxious and volatile mantle of dry, loose excrements, mixed with vegetable remains, covering up and spoiling by its intermixture the nitrous earth resting in lumps beneath it, and thus sufficiently explaining why, as far as saltpeter digging was concerned, that part of the cave had never been disturbed.

We were directly upon the cave path, where back and forth over the dusty manure all footsteps of all saltpeter hunters, all white men, all Indians, choosing to penetrate deeper into the cave, must needs have passed. Their trampling had draggled the surface, kicking earth into it from other areas, or dropping "peter dirt" upon it from bags. Moreover, charred pieces of resinous pine, Pinus mitis, twigs of hazel, Corylus americana, and fragments of burnt cane, Arundinaria tecta, strewed the surface, representing doubtless the remains of the torches of such white niter hunters as had not had lamps or candles, and, we may reasonably suppose, of the Indians who had preceded them. The appearance of this surface film, then, which I have called

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* Abstract of paper by Henry C. Miller, curator of the Museum of American and Prehistoric Archæology at the University of Pennsylvania, read before the American Philosophical Society.

* I take pleasure in returning the thanks of the department and of myself to our vice presidents, Dr. William Pepper, who alone defrayed the expenses of this expedition.

at Lookout Cave) had been cast away at the spot by Indians.

Our party of four, Mr. G. B. Johnson, James Priest, my assistant, Joseph Musselman, and myself, had stopped, and Priest, our guide, holding down his candle, pointed to a hollow caused by digging in the mass of dry manure, where he, about 1884, while filling several bags full of the "fertilizer," as he called it, for his garden, and later Mr. Johnson himself, on a similar

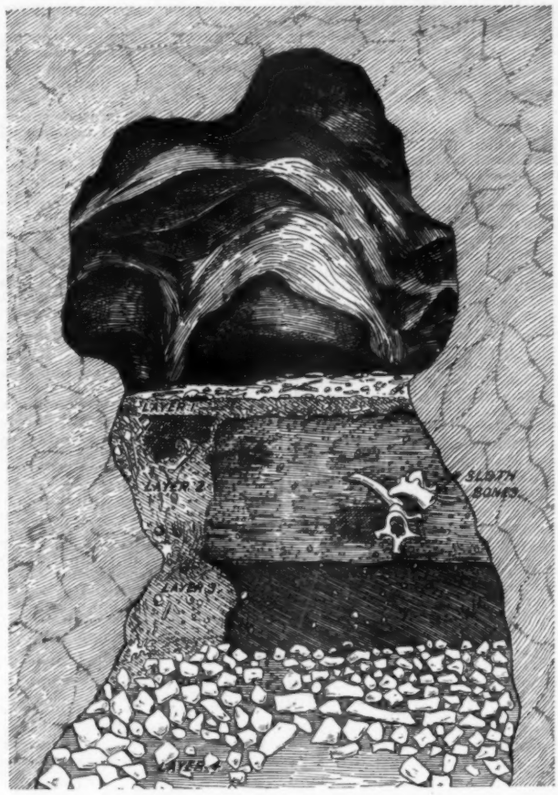


FIG. 3.

Diagram showing a vertical section of the gallery in Big Bone Cave where the sloth bones were found. Layer 1 (2 ½ inches), disturbed surface rubbish with charred torch ends. Layer 2 (2 to 2½ feet), dry loose rat excrement, animal and vegetable remains, etc., with sloth bones. Layer 3 (1 foot), crusted lower portion of rat excrement and vegetable remains formed before the advent of the sloth bones. Layer 4 (of undetermined depth), loose pieces of nitrous clay, dry and hard, mixed with manure. The disturbance resulting in the intrusion of torch ends and other objects into the deposit as far as Layer 4, caused by burrowing rats, is seen against the left cave wall.

errand, had found several vertebræ, ribs, the pelvis and the skull with teeth of a large animal (the extinct sloth), which, after remaining for some time at the house of Mr. Johnson, had been sent to Nashville and sold. For this reason, and as well testified by the letters to me of Prof. J. M. Safford, State geologist of Tennessee, who first advised my exploring the cave, let it be said in parenthesis that without doubt the sloth skull now in the possession of Prof. Safford, at Nashville, and which I have been unfortunately unable to obtain from him for comparative study, is the skull thus found by Priest, and because this skull and the other bones belonging to Prof. Safford, corresponding to those described as found by Priest and Johnson at this place, also show cartilage, and further because the evidence indicates that there was only one sloth at this point, with no reason shown why there should have been more than one, and because it appeared that no other spot adapted for the discovery of fossil bones had existed at the entrance of the cave, for these reasons, I believe that the Nashville bones and my set go together as parts of one animal; and further, as first suggested by Prof. Safford and now shown by my examination, let me add that still another and a third set of sloth bones, belonging to the Academy of Natural Sciences, of Philadelphia, herewith shown (see Fig. 2 for one of them), found by a farmer in the cave and described by Dr. Harlan in 1835, also showing cartilage equally fresh in appearance and referable to a young animal (because of the loose epiphyses) may well be believed to constitute skeletal portions of the same individual.

These subsequently arrived at conclusions, however, did not concern us when, first pausing in the candle light, we placed our tools and baskets upon the ground to listen to the account of Priest. Our hope of finding more bones depended upon the chance that he had not dug up the whole floor and that other remains, resting beyond the limit of his digging, had escaped him and remained to reward our search.

Down through the manure and nitrous earth resting beneath it, from nine in the morning till five in the afternoon, beginning where the consistency of the deposit showed that Priest and other diggers had left off, we worked in the dim candle light, until our hunting had accomplished its object, and until the walls of our trench revealed the facts herewith described, and first that of a sequence in time marked by the layers that had accumulated upon the foothold, and of which two epoch-denoting divisions confronted us. They consisted of (below and older) a water-deposited nitrous clay, resting upon the bottom rock, standing for a time when the cave was wet, and (above and later) the manure previously referred to, testifying to an epoch when the cave was dry, and to the latter division with its subdivisions described as Layers 1, 2 and 3, and hence to the later time belong the sloth bones here shown. One after another they were found in the dry manure, which, lying invariably under Layer 1 above described, I have called

LAYER 2.

(Two to two and a half feet thick. See Fig. 3.)

As we worked forward through this layer with shovel, hands and trowel to where it thinned out and the saltpeter earth now removed had formed the foothold beyond it, we found it to consist almost entirely of well preserved, dry excrements of the cave rat, Neotoma magister, which, intermixed in lesser quantity with coprolites of porcupines, Erethizon dorsatus, formed the conspicuous ingredients of the mass. In consistency like a bin of oats, the deposit answered every disturbance with a cloud of pungent dust. Nuts, sticks, fur and moss were easily seen in it by candle light, but more minute search in the cave and a subsequent study of the specimens preserved revealed at various points the seeds, grass, bark, leaves, hair and small botanical fragments described later. In the midst of this interesting rubbish, often in contact with seeds, nuts and hair, appeared the twelve sloth bones found, protruding from the vertical side of the trench at depths of from eight to fourteen inches.

The first bone found (see Fig. 4) was an epiphysis of a humerus. Then came a well preserved vertebra No. 2 (see Fig. 5), found at a depth of one foot eight inches below the surface and one foot from the right wall of the cave. The small coprolites touched it on all sides. Just above it lay a small twig of wood, and close to it several bones of bats, described later, while both above and below it we noticed wads of fine hair. The deposit was exceedingly dry, and its removal filled the cave with suffocating dust clouds. Immediately in contact

FIG. 5.

The second bone found (in Layer 2, depth 1 foot 8 inches). Dorsal vertebra.

with bone No. 2, as we worked horizontally into the bank, lay bones Nos. 3, 3½ and 4, two unseparated vertebræ with a loose epiphysis resting between them, directly under which we found two gnawed hickory nuts and an acorn.

As we advanced vertically into the manure, another vertebra, the fifth bone found, bone No. 6, the heel bone (calcaneum), and bone No. 7 (the astragalus), were revealed lying but a few inches apart. With deep interest I removed them. Just below the fifth bone, at which point the deposit had hardened considerably (Layer 3) and was mixed with fine pieces of saltpeter earth, another acorn was found, and still another under the astragalus.

On that day, May 6, 1896, at 3:15 in the afternoon, with the wind blowing from the north, a slight draught of air wafted the currents of dust inward as we worked, while, to testify to the open communication of that part of the gallery and the outer world by means of the roof holes, a small cricket appeared, crawling upon the disturbed earth as we worked at the third bone.

A considerably gnawed rib fragment (see Fig. 7) was followed by a loose epiphysis, and a final vertebra, the tenth bone found, lay against the rock wall on the right, not much more than eight inches below the surface, where, close to the top of the deposit and still against the wall, the wads of hair were best preserved. Here also were found a gnawed butternut, several pieces of grass, several small bat bones and dung as usual. The position of these latter objects close to the wall caused us to suspect that they had slid down from the surface, just as close to the left side twigs of leaves had probably been intruded in the rat holes. But the objects found at or below the position of the other bones we regarded as of equal age with them, and as truly indicative of the nature of the layer.

Our observation of the position of all the bones showed that they were not (with the exception of the two vertebræ and epiphyses) in skeletal order; several epiphyses were loose; the calcaneum (heel bone) lay close to the vertebræ; the single rib found was broken and turned. Unquestionably the bones had been

FIG. 4.

First bone found (in Layer 2, depth about 18 inches), epiphysis or unknitted end of the humerus of a young sloth, Megalonyx. Photographed, resting upon the characteristic rubbish of Layer 2 found around it. 1. Bat's jaw, Adelonycteris fusca. 2. Hickory nut and fragment gnawed by rodent, Hicoria glabra. 3. Excrement of large mammal, possibly sloth. 4. Felted hair of bats, rats, and porcupines mixed with a woolly fur, possibly belonging to the sloth itself. 5. Bones of the bat, Adelonycteris fusca. The background is composed of a mass of dry coprolites of cave rats, brown dusty earth, and fragments of hard cave clay, "peter dirt."

dragged and twisted out of place (inferentially by the gnawing rats or the porcupines) since their deposition. Some may have been carried away to hidden crannies through burrows noted later communicating with the rubbish.

(To be continued.)

THE FORESTS OF ALASKA.

THE great maritime forest of northwestern North America, which at the south embraces the redwoods of California and spreads over western Oregon and Washington, terminates on the Alaskan coast on the eastern shores of Kadiak Island, just below the fifty-eighth degree of north latitude. Taken as a whole, this coniferous forest is unequaled in productiveness and in the size, beauty and value of its trees. Not only is the redwood the largest of all conifers, with the single exception of its relative of the Sierras, which excels it in bulk of stem and branches, but not in height, but in this maritime forest are found the largest spruce tree and the largest hemlock in the whole world. Of the arbor-vitæs here grows the giant of its race; and of all the cypress tribe none can equal Lawson's cypress in majesty of port. Here, too, the alder becomes a great tree, and firs assume their noblest proportions.

To-day, however, we would speak more particularly of that part of this forest covering the coast mountains of southeastern Alaska, and which in many of its general features resembles the forests of Puget Sound and of western British Columbia, although the Douglas spruce, the most abundant tree on the shores of Puget Sound and Vancouver Island, where it surpasses all its associates in height and in size of stem, does not reach Alaska. The white fir (Abies grandis), which is so conspicuous with its tall pyramids of lustrous dark green foliage on the shores of the Gulf of Georgia, is absent, too, from the Alaska forest, as is the great-leaved maple (Acer macrophyllum), abundant in all the coast region further south. The arbor-vitæ (Thuya gigantea), which is common and of fine size on Prince of Wales Island and on the southern part of the Cleveland Peninsula, is rare, if it exists at all, north of latitude fifty-six; and the coast forest of southeastern Alaska is composed almost entirely of two trees, the Sitka spruce (Picea Sitchensis) and Merten's hemlock (Tsuga Mertensiana). From the edge of tidewater these two trees grow up to the timber line, which varies in elevation from 2,500 to 4,000 feet, everywhere in dense, serried masses, like the blades of grass in a meadow, covering all islands and the seaward slopes of the mainland mountains, which shut off the moisture from the dry interior. Sometimes the spruces predominate, especially toward the north; sometimes the hemlocks are more abundant, and often the two are mixed in nearly equal numbers. Through this forest the Sitka cypress (Cupressus Nootkatensis) is scattered, usually at elevations of about 1,000 feet above the sea level, although it often descends to the water's edge. It grows, not in large bodies, but often in numbers sufficient to enliven the somber spruces and hemlocks with the cheerful yellow tints of the graceful frond-like branchlets which descend from the wide-spreading branches of this splendid tree, unrivaled by any other American conifer in the beauty and value of its wood. On the margins of the little flats and beaches which occur only at the mouths of streams—for on the Alaska coast the mountains usually rise abruptly from the sea—alders of two kinds and the lovely Sitka willow light the borders of the forest; and alders sometimes extend up the banks of streams or hang over rocky sea cliffs. On sloping seashore bogs, rich in mosses and studded with many charming herbs and dwarf shrubs, Pinus contorta, the only Alaskan pine, occurs rather sparingly; and on Baranof Island, near the town of Sitka, Patton's spruce (Tsuga Pattoni), which is probably widely distributed over the coast mountains at high altitudes, descends with a few small individuals nearly to the sea level. These, with the addition of the balsam poplar, which is only seen near streams, and the little Rocky Mountain maple (Acer glabrum), are the only trees of the coast forest of southeastern Alaska, which is remarkable in its poverty of species, in its richness in individuals and in the size these attain in the thin soil, a few inches deep at best, and often on the nearly perpendicular slopes of these glacier-swept hills. They are wonderful, too, in the deep mosses of the forest floor, and in their impenetrable undergrowth of blue berries of many varieties, salmon berries, menziesias, and the terrible devil's club (Panax horrida), which so cover the ground with their entangled stems that travel through the woods is practically impossible.

As compared with trees in forests further south, those of Alaska are not large, although spruces and hemlocks a hundred and fifty feet high, with trunks three or four feet in diameter, are not rare at the sea level as far north as Baranof Island; ascending from the shore, however, the trees rapidly decrease in size and near the timber line become small and stunted, as they often do at the sea level at the heads of the numerous estuaries and fiords cut deeply into the mainland coast range.

The deepest and most interesting of these fiords, the Lynn Canal, a narrow continuation of Chatham Strait, extends a hundred miles northward from the coast nearly to the sixtieth degree, and at its head is fed by the waters of the Chilkat, the Chilkoot and the Skagway rivers, swift mountain streams, which afford difficult passage across low passes into the interior to the headwaters of the great western tributary of the Yukon. The forests at the head of the Lynn Canal differ somewhat from those in the region nearer the coast. The narrow bottom lands are covered with masses of balsam poplar or with the so-called green alder, which here becomes a tree fifty feet high. The spruce is still abundant at the river level and on the lower slopes, but it is everywhere small and stunted. The hemlock also occurs here, but only sparingly, and not of large size. The pine is seen on the flats and at considerable elevation on the hillsides, but here its leaves are broader than those of the coast trees, and it is passing into the variety Murrayana of the interior plateau, the Lodge pole pine of our northern Rocky Mountains. A white birch is very common at low elevations, and is more like the birches of Siberia and northern Japan than any described American species, and growing with it is Acer glabrum, which is certainly the most widely distributed of all the North American maples, and probably the most boreal member of the genus, and Patton's spruce is at the timber line.

When these passes from the humid coast region to the dry interior are crossed, an entirely different forest is encountered. The hemlock and the Sitka spruce have disappeared, and the largest tree in the open scattered groves near the shores of Lake Bennett and Lake Linderman is a fir (Abies lasiocarpa). With it grow stunted white spruces (Picea alba), which in greater or lesser abundance and mingled with balsam poplars, birches and alders are scattered over the basins of the Yukon and its tributaries for hundreds of miles, and finally reach the Pacific coast on Kotzebue Sound within the Arctic Circle, and nearly five degrees north of Kadiak Island, where the forests of southeastern Alaska give way to a growth of grasses and low alders and willows.

Trees cannot be cut lawfully in Alaska for timber or fuel, for there is no law which permits the sales of stumpage or timber lands, and no law relating in any way to the forest but the one which forbids all shipment of wood from the Territory. There are a few sawmills in Alaska, however, and the number will soon be increased, and a large quantity of fire wood is consumed at the salmon canneries and quartz mines, but the government gets nothing for it, and is powerless to prevent damage to the public domain. Fortunately, the climate of southeastern Alaska is so humid that forest fires are rare, and never very destructive, and reproduction is sure and rapid. These forests, therefore, even with American methods, will not soon or easily be destroyed; and here and to the southward along the coast ranges and islands of British Columbia through nine degrees of latitude from Cross Sound, at the north of Chicagof Island, to the Straits of Fuca, is now the greatest continuous body of coniferous timber in the world, almost unmarked as yet by the ax, safe from fire and of easy access, from which the world will be able to draw great stores of material when the redwoods and Douglas spruces of the South have fallen, and our south Atlantic and Gulf shore pineries are only dim memories.—Garden and Forest.

THE MINISTRY OF LEAVES.

IN the body of an animal there is always going on a process of slow combustion; oxygen taken in by the lungs enters into union with carbon derived from the food, carbonic acid is formed, and heat evolved. Every atom of carbon disengaged from oxygen by the plant represents an expenditure of heat upon the leaves equal to that developed during its combination with oxygen in the animal system. In the leaves this heat disappears; it becomes latent, and is stored up as potential energy. When we burn a piece of wood, not only is the carbon which the tree originally extracted from the air restored to the atmosphere in the form of carbonic acid, but the heat given out by the burning wood corresponds exactly to the amount by which the sunbeams were chilled through the activity of the leaves while the wood was growing. Robbing the sunshine of its heat in this way, leaves must act as refrigerators. Leaves exert a further cooling influence on account of the watery vapor they are constantly giving off, for whenever water evaporates, much heat is rendered latent and ceases to be discerned by the senses. A man is said to exhale about one hundred gallons of carbonic acid in a day. Boussingault estimated that a square yard of leaf surface, reckoning both the upper and lower sides of the leaves, can, under favorable circumstances, decompose rather more than a gallon of carbonic acid in a day. At this rate, one hundred square yards of leaf surface should keep a man going with oxygen. A single tree would suffice for quite a number of people, for, according to the late Prof. Asa Gray's computation, even a moderately sized elm possesses five acres of leaf surface.

Widely as they differ in appearance, a lung and a leaf are constructed on very similar principles. In the lungs the air tubes are subdivided into an infinite number of small ramifications, around which the blood vessels are distributed in an extremely fine network. By this arrangement an immense surface is exposed to the air, with comparatively small expenditure of space. Through the delicate membranous walls of these fine tubes the air penetrates into the blood vessels beneath, and from the blood carbonic acid diffuses into the air tubes, and is exhaled. The typical leaf, again, is a thin expanded plate, offering a large surface to the air relatively to its mass; its lower stratum is honeycombed with innumerable air spaces and intercellular passages, which communicate with the external air through thousands of pores or stomata. Oxygen and carbonic acid are exchanged through the walls of the leaf cells very much as in the lungs, but in the reverse order. The flattened form of the leaf secures illumination and promotes evaporation; lungs, having no need of light, are shaped to suit the space available. The resemblance between the submerged leaves of aquatic plants, such as the water buttercup, and the external gills or branchiæ of the young tadpole and other amphibians, is particularly striking. Both organs are cut up into fine, threadlike segments, giving them a fringed or featherlike appearance. The large absorbing area thus presented to the water facilitates the absorption of the dissolved gases. Leaves are, however, organs of nutrition. This resemblance to respiratory organs arises entirely from the fact that by far the largest proportion of a plant's food is absorbed in the gaseous condition. Referring to this adaptation of the leaf, Johnstone, in his "Agricultural Chemistry," says: "How beautiful is the contrivance of the expanded leaf! The air contains one gallon of carbonic acid in two thousand five hundred, and this proportion has been adjusted to the health and comfort of animals, to whom this gas is hurtful. But to catch this minute quantity, the tree hangs out thousands of square feet of leaf in perpetual motion, through an ever-moving air; and thus by the conjoined labors of millions of pores, the substance of whole forests of solid wood is slowly extracted from the fleeting winds."

Chlorophyl itself owes its formation to light; but to conceive how the ethereal undulations, acting on the living substance of a leaf cell, can elaborate a structure so complex, baffles imagination. How marvelous are the properties of light and how manifold its adjustments to differently constituted materials! Light is at once the most useful of natural agencies and the most beautiful of physical phenomena. And yet it must be tempered to our vision. Painful and blinding the glare from rock or desert, but what more grateful than the sight of fresh green meadows! In contact with the grass light is purified from rays which fatigue and injure our eyes. This tempering of the sunshine is another of the many benefactions we owe to the ministry of leaves.—Alex. S. Wilson, in Knowledge.

HOT SODA WATER DRINKS.

HOT soda is served by drawing 1 or 1½ ounces of the flavoring preparation, sirup, extract, juice, etc., into the mug, adding cream and sugar, if these be required, filling the cup with hot water, and serving with a spoon. The amount of flavoring stated is intended for an 8 ounce mug. Sometimes the beverage is topped off with whipped cream or with a spice. Here are some formulas:

Chocolate.

Baker's fountain chocolate	1 pound.
Sirup	1 gallon.
Extract vanilla, enough.	

Shave the chocolate into a gallon porcelained evaporating dish and melt with a gentle heat, stirring with a thin bladed spatula. When melted remove from the fire and add one ounce of cold water, mixing well. Add gradually one gallon of hot sirup and strain; flavor to suit. Use one ounce to a mug.

Hot Egg Chocolate.

Break a fresh egg into a soda tumbler; add 1½ ounces chocolate sirup and 1 ounce cream; shake thoroughly, add hot soda slowly into the shaker, stirring meanwhile; strain carefully into mug, top off with whipped cream and serve.

Hot Chocolate and Milk.

Chocolate sirup	1 ounce.
Hot milk	4 "

Stir well, fill mug with hot soda and serve.

Coffee.

(1) Coffee sirup may be made by adding boiling water from the apparatus to 1 pound of coffee, placed in a suitable filter or coffee pot, until 2 quarts of the infusion are obtained. Add to this 3 pounds of sugar. In dispensing, first put sufficient cream in the cup, add the coffee, then sweeten, if necessary, and mix with the stream from the draught tube.

(2)	Mocha coffee (ground fine)	4 ounces.
	Java coffee (ground fine)	4 "
	Granulated sugar	8 pounds.
	Hot water	q. s.

Percolate the coffee with hot water until the percolate measures 72 ounces. Dissolve the sugar in the percolate by agitation without heat and strain.

Lemon.

Lemon sirup is, of course, best prepared when the juice of the fruit is squeezed into the glass, powdered sugar and hot water added, and the whole shaken well in a shaker. When this is not possible, lemon juice previously prepared is the best substitute. Try the following formula:

Lemon juice	1 ounce.
Hot soda sirup	4 "

Mix with stream from draught tube.

Ginger.

Fluid extract of ginger	2½ ounces.
Sugar	40 "
Water, to	2½ pints.

Take 10 ounces of the sugar and mix with the fluid extract of ginger; heat on the water bath until the alcohol is evaporated. Then mix with 20 ounces of water and shake till dissolved. Filter and add the balance of the water and the sugar. Dissolve by agitation.

Hot Egg Coffee.

Break a fresh egg into a soda tumbler; add 1 ounce coffee sirup; shake thoroughly, add hot milk slowly into the shaker, strain carefully into mug, top off with whipped cream and serve.

Cocoa Sirup.

Cocoa, light, soluble	4 ounces.
Granulated sugar	2 pounds.
Boiling hot water	1 quart.
Extract vanilla	1 ounce.

Dissolve the cocoa in the hot water, by stirring, then add the sugar and dissolve. Strain, and when cold add the vanilla extract. To dispense,

Cocoa.

Cocoa sirup	2 ounces.
Cream	1 "

Turn on the hot water stream and stir while filling. Top off with whipped cream.

Hot Soda Toddy.

Lemon juice	2 fl. drachms.
Lemon sirup	1 fl. ounce.
Aromatic bitters	1 fl. drachm.
Hot water, enough to fill an 8 ounce mug.	

Sprinkle with nutmeg or cinnamon.

Hot Orange Phosphate.

Orange sirup	1 fl. ounce.
Solution of acid phosphate	1 fl. drachm.
Hot water, enough to fill an 8 ounce mug.	

It is prepared more acceptably by mixing the juice of half an orange with acid phosphate, sugar and hot water.—Pharmaceutical Era.

A French inventor has made use of a rubber tube as a core on which to mould pipes of cement and sand. To make a continuous conduit in the ground, a trench is dug, and at the bottom of this is placed a layer of cement mortar. On this rests the rubber tube, which is surrounded by canvas, and inflated. The remainder of the trench is then filled with cement mortar, and as soon as this is set the rubber core can be deflated and removed for use elsewhere. It is stated that 6 in. pipes have been made on this plan out of hydraulic lime and sand, at a cost of about 22 cents per yard.

ENGINEERING NOTES.

The Railroad Gazette estimates that to put the railway rolling stock of the United States on a normal basis of efficiency, orders this year will have to be given to the shops and factories for 2,342 locomotives, 97,246 freight cars and 5,400 passenger cars. During the past nine months of the current year locomotives to the number of 771 have been ordered, freight cars 27,700, and 179 passenger cars. Only 77 railway companies have ordered new engines, and the freight car orders have been placed by about the same number of companies. About one-third the number of locomotives have been ordered that should be built to thoroughly equip the roads. The freight cars which have been ordered are less than one-third the number which estimates designate as the requirement necessary to bring equipment up to a proper standard. Orders are about one-third the number built in 1890. The Lumberman adds that "thus it can be seen that the prospects for work in the car factories for the remainder of the year are good. The activity already developed is not likely to flag for months, but, rather, is likely to increase."

Some interesting experiments to ascertain the influence of cold upon the bending properties of wrought iron, Siemens-Martin open-hearth steel, Thomas steel, spring and cast steel, have been made by Prof. M. Rudeloff, director of the imperial German testing station, says The Engineer. The samples were rounded off on the edges; the tests were made in a press. Cooling down to —20° C. exercised but little influence upon the flexibility of the different materials tested. Only in the case of spring steel and forged iron a reduction of the bending angle was observed, from 91° to 84° with the former and from 150° to 139° with the latter, while the other samples could be bent together at —20° C. as well as at ordinary room temperature, so that the two shanks covered each other, equaling a bending angle of 180°. The flexibility was in some cases at —20° C. even higher than at ordinary temperature, only in the case of Siemens-Martin and Thomas steel it declined from 100 to 80. The samples showed at the bending place no change in the material that might have been caused by the cooling down to —20° C. A cooling to —80° C. had likewise very little influence upon the flexibility of soft rivet iron and rolled puddled iron, but the flexibility of the other materials suffered by the lower temperature, especially cast and spring steel.

The degree of accuracy attainable in modern naval gunnery in actual warfare is something yet to be determined. With the exception of the battle of the Yalu during the Chino-Japanese war, there had been no opportunity for finding out what might be accomplished at long range by a modern gun, mounted on so unstable a platform as the deck of a rolling vessel; and the value of the Yalu fight as an object lesson in this respect was impaired by the relatively unskilled character of the gunners, says Cassier's Magazine. Certain it is that while death and destruction were meted out all around in that encounter, an enormous amount of ammunition was used up in the work. The bombardment of Alexandria by the British fleet in the early eighties afforded none of the conditions of a sea fight, since the vessels were at anchor in practically smooth water and their target was certainly immovable enough; and even there the expenditure of powder and shell was out of all proportion to the damage inflicted. The point has recently been made, however, that, after all, it is astonishing that a ship is ever struck by a projectile from a gun, and that there is probably more luck than cunning in the art of modern naval warfare. In a lecture at the United States Naval War College at Newport, Prof. Alger, a short time ago, stated, for example, that at a convenient fighting distance, say two thousand yards, a modern battleship, like the Indiana of the United States navy, appears to be of the same size as a picture of her, eight-tenths of an inch long, held at the point of clear vision, about 14 in. from the eye, while the outlines of the real ship will be much less clear and distinct than those of the picture. The height would, of course, appear to be still less, so that the difficulty of hitting such a target, even with the ship at rest and the gun in a fort, instead of both moving more or less rapidly, can be appreciated at least to some extent. The element of luck truly must enter largely into effective fire under such conditions.

Capt. G. A. Chaddock, F.R.G.S., a Liverpool navigator of thirty years' experience in both steam and sailing craft, has invented an appliance which ought to be of immense value to shipowners and their crews all the world over in saving both life and property. The present wooden hatches, laid on from above, are easily forced up by the inrush of water consequent upon a hole being knocked in the bottom of a vessel, the results being that she rapidly tips and sinks. The telescopic iron hatches, which constitute Capt. Chaddock's invention, are so arranged that the pressure of water from below would, in such a contingency, bind them more tightly in their places, precluding the possibility of the water rising above the first deck, which forms a platform or horizontal bulkhead, preventing the ship from sinking and water from reaching the cargo from above. The improvements give more effective ventilation to prevent cargo heating and sweating, and are also capable of being hermetically sealed, so as to neutralize fire, and, generally speaking, watertight compartments are doubled, the consequent seaworthiness of a vessel being vastly increased. Besides these essential advantages there are many others, as, for instance, more speedy manipulation and no risk of injury by careless handling. Bad smells from cargo do not reach the passengers. The vessel would be a salvage appliance in herself in case of stranding, and last, but not least, the hatches are particularly suitable for deep water ballast tanks. The practical effect of Capt. Chaddock's improved hatches will be to multiply the watertight divisions of a ship in proportion as the number of decks are to bulkheads. Thus a ship with eight bulkheads and three decks would at present have only nine watertight compartments with wooden hatches, but with the improved hatches and watertight decks the same ship would have twenty-five compartments, an increase of sixteen extra compartments. Capt. Chaddock's improvements have been submitted to the leading shipowners, underwriters, marine engineers, and other practical men, both in Europe and the United States, and they have spoken of them in the highest terms.

MISCELLANEOUS NOTES.

That galvanized sheets which are made of steel with the oxide formed in rolling removed, and then coated with spelter, are not more generally used in boiler or tank works is because the advantages they possess are not fully understood, says The Iron and Coal Trades Review. It is, however, well for boiler makers to remember that the action of moisture, especially when impregnated with sulphur arising from soft coal, has a destructive influence on steel plates, rusting them rapidly, particularly in the lighter gages. This may be delayed by frequent painting or varnishing. A coating of spelter makes steel sheets impervious to moisture, and therefore the life of the metal is preserved almost indefinitely, especially where it may be painted with the ordinary preservatives from time to time.

The ventilation of the Metropolitan Railway, of London, has at various times given rise to a considerable amount of well grounded complaint. It is, however, a matter which, in some respects, has been the cause of needless alarm. Needless because, although the ventilation on some parts of the line is unquestionably bad, yet it has been proved that the atmosphere does not contain elements of positive danger. At the best, however, this atmosphere is, as regards personal comfort, most objectionable, although it is not so inimical to health as is generally supposed. This is evidenced by the healthy condition of those employes of the company who are obliged to spend a considerable portion of their time on the underground line. That this atmosphere does affect some persons is not to be denied, but that it is not absolutely dangerous to health is shown by the fact that one of the Metropolitan Company's servants has worked for twenty years on the line at Gower Street without detriment to his health, while another, who has spent twenty-five years in a similarly circumstanced station, is as healthy as can be desired.

Owing to transport difficulties, and also to the sluggishness and poverty of the rural population of certain districts of the Austrian empire, some peculiar methods of trading in salt have survived in Galicia, for instance, says the Trade Journals Review. For the purpose of easy transport, and in order to facilitate the retail trade, the salt is supplied in the compressed state, and the government salines of Ischl are now introducing a briquette press, invented by Philip Mayer, which turns out 1,000 bricks of salt of 0·6 kg. (1·3 lb.) each per hour. The moulds are mounted in three or four groups of six or more on a revolving table. Around this table are arranged the appliances for weighing, for filling and emptying the moulds, and the press. The apparatus requires three attendants. One man takes charge of the weighing; the second makes the brick by manipulating two levers; the third removes the finished brick. With the first machine of this kind, each operation took 17 seconds, that is to say, one set of salt cakes was delivered after that period. But larger machines have already been ordered by the Netherlands, for their East Indian colonies. In these machines up to 16 moulds are united in one group, so that 16 bricks are delivered simultaneously. Each brick is subdivided and can easily be broken into four parts, and weight and price are stamped into each brick.

As the question of good joints for conduit pipes is one of considerable interest, the Nouvelles Annales de Construction draws attention to the device, first adopted about five years ago at Elberfeld in the Wupper valley, by the well known hydraulic engineer of Frankfort-on-the-Main, J. Lindley. At Elberfeld the conduits lie in an exceedingly permeable soil. The joints have answered perfectly, and they are made easily and rapidly; the materials are, perhaps, a little expensive. The joint in question has been used with pipes widening out at one extremity in the usual fashion. The two pipes are placed in position, a tarred cord is pressed into the recess, and a little clay funnel is made on the outside, through which the mixture is poured into the ring-shaped recess between the two pipe ends, which is closed by a flat rubber washer, well greased on the one side, and held in position by a steel collar. The mixture consists of two parts, by weight, of tar and one of asphalt. It hardens within less than a minute, when the rubber washer and the clay are removed. The joint is now perfect, and the canal need no longer be kept dry, so that the operations are much more expeditious than with cement. As regards expense, a pipe a foot in diameter would require about 4 lb. of mixture, ½ lb. of cord, and the operation would cost a little less than sixpence. A much more exhaustive article on pipe joints, from which the Nouvelles Annales possibly drew their information, is published in the Gesundheits Ingenieur by Unna.

The following methods are recommended for the detection of artiiicial silk. Mr. P. Truchot, in the Annales de Chimie Analytique, says that in burning no acid vapors are evolved, nor is the odor of burned horn noticeable. Schweitzer's reagent largely swells both kinds of silk before they pass over into solution; an addition of water or hydrochloric acid precipitates the artificial silk as a white, flaky cellulose. When dissolved in pure sulphuric acid (66° Bé.) artificial silk forms a deep yellow sirupy fluid, which is colored dark blue by the addition of a solution of diphenilamine sulphate. The presence of artificial silk may also be detected direct, without solution, by dipping a small clipping of the fabric to be examined into a solution of diphenilamine sulphate, whereby every thread of the artificial silk is tinged dark blue, while natural silk remains entirely unaffected. Without resorting to chemical methods, a very simple way of recognizing artificial silk is given in the Dry Goods Chronicle, and one which ought to be invaluable to buyers of dress goods. A wood pulp silk is now used to a large extent in foreign made fancy goods to give a brighter effect than can be imparted to the fabric by the use of natural silk. The test is to unravel the threads of the fabric and put the silk strands into the mouth and masticate it vigorously. Artificial silk readily dissolves under this operation and breaks into minute particles, and when pulled between the fingers shows no thread, but a mass of cellulose or pulp. Natural silk, no matter how thoroughly it is masticated, will retain its fibrous strength. The artificial silk offers no resistance to the teeth, which readily go through it, whereas natural silk does. It is sufficient to moisten the thread on the tongue and then submit it to a pull between the fingers. Natural silk will resist a strong pull, wet or dry.

SELECTED FORMULÆ.

Picture Transferrer.—A very weak solution of soft soap and pearlashes is used to transfer recent prints, such as illustrations from papers, etc., to unglazed paper. Such a solution as—

Soft soap	½ oz.
Pearlash	2 dr.
Distilled water	16 fl. oz.

The print is laid upon a flat surface, such as a drawing board, and moistened with the liquid. The paper on which the reproduction is required is laid over this, and then a sheet of thicker paper placed on the top, and the whole rubbed evenly and hard with a blunt instrument, such as the bowl of a spoon, until the desired depth of color in the transfer is obtained. Another and more artistic process is to cover the print with a transparent sheet of material coated with wax, to trace out the pictures with a point, and to take rubbings of the same after powdering with plumbago.—Brit. and Col. Drug.

Transparent Photographic Prints.—The Photographic Times gives this method: If on albumen paper, soak the print overnight in a mixture of eight ounces of castor oil and one ounce of Canada balsam. Plain paper requires a much shorter time. When the print is thoroughly soaked, take it from the oil, drain well and lay it on the glass, face downward, and squeeze till all is driven out and the print adheres. If a curved glass is used, prepare a squeegee with edge parallel with the curvature of the glass. It will take several hours before the print is dry enough to apply color to it.

(2) Fix a paper photograph upon a cushion-shaped glass with transparent cement; when dry, rub away two-thirds of the thickness of the photograph with sand paper. The thin film is then rendered transparent by soaking it in melted paraffin wax, after which transparent colors are applied, which appear softened down when looked at from the front. The background and heavier portions are then painted in body color upon the face of another cushion-snaped piece of glass, which is afterward fixed behind the first one.

For coloring photographs, The Era Formulary gives this process:

Take any unmounted photographic print which it is desired to color and place it on a pane of glass, the face toward the glass. In this way the image will be seen through the back of the paper. With an ordinary pencil mark on the back of the print a rough tracing of the outlines of the photograph, marking the places where the colors must afterward be applied. When this tracing has been made, remove the photograph, lay it on blotting paper and apply the colors to the back of the print. The colors should be spread on in flat tints, it not being necessary to use demi-tints. For example, a flesh tint is put on the face and black or brown on the hair; if the picture is a landscape, the trees are colored dark green, the sky part blue. It is important to use strong colors, which will show through the paper better. After this operation is finished, and when the colors are dry, the photograph is rendered transparent as follows:

First prepare the following solution:

Benzine	10 parts.
White vaseline	1 "

The vaseline is dissolved in the liquid and then the mixture is ready for use. Then the photograph, which has been colored previously, is placed on some sheets of white paper, and the back of the picture is saturated first, pouring the solution on it and rubbing with the finger to cause the mixture to penetrate, first the color and then the paper. The print is then turned face upward, and this side is saturated in the same way. After this operation the paper becomes oily and transparent and the color begins to show through. It is left to soak thus for an hour or two, then both faces are rubbed with linen until no oily spots are seen, when the proof is placed on white paper. The operation is then completed and the proof has only to be pasted on cardboard, the same as other photographs. But, as the paper is still saturated with vaseline, water paste will not answer, and the same kind of varnish will have to be used. This process of painting, which can be used by anyone, gives very beautiful effects. Colors which are thus applied to the back of the photograph give it a tone of admirable freshness, and the vaseline mixture brings the image out. Besides, as the colors have the thickness of the paper to pass through, they are greatly softened and thus approach nature. The variations of the tints will be seen, by transparency, when looking at the picture. As to the colors, any that are at hand can be used, whether water colors or oil colors. The essential point is to choose the strongest colors, rose, green, etc., and to put on only a very thin layer, as otherwise the vaseline cannot pass through it.—Pharmaceutical Era.

Yellow Coloring for Beverages.—The coloring agents employed are fustic, saffron, turmeric, quercitron and the various aniline dyes. Here are some formulas:

(1) Saffron 1 oz.
Deodorized alcohol 4 fl. oz.
Distilled water 4 "

Mix alcohol and water, and then add the saffron. Allow the mixture to stand in a warm place for several days, shaking occasionally; then filter. The tincture thus prepared has a deep orange color, and when diluted or used in small quantities gives a beautiful yellow tint to sirups, etc.

(2) Ground fustic wood 1½ ounces.
Deodorized alcohol 4 fl. ounces.
Distilled water 4 "

This color may be made in the same manner as the liquid saffron, and is a fine coloring for many purposes.

(3) Turmeric powder 2 ounces.
Alcohol, dilute 16 "

Macerate for several days, agitating frequently, and filter. For some beverages the addition of this tincture is not to be recommended, as it possesses a very spicy taste.

The non-poisonous aniline dyes recommended for coloring confectionery, beverages, liquors, essences, etc., yellow are those known as acid yellow R and tropæolin 000 (orange I).—Pharmaceutical Era.

THE EMPEROR WILLIAM MONUMENTS AT MAGDEBURG AND COBLENZ.

THE year now drawing to a close has been signalized by two events of considerable importance. The sixtieth anniversary of the reign of Queen Victoria was celebrated in England during the summer with ceremonies befitting this extraordinary event, and about the same time Germany was making a fête day of the centennial anniversary of the birth of the great Emperor William. This occasion had a double meaning to the German race and signified not only a token of remembrance to him whom they regarded as a great and good man, but stood as well a memorial of the birth of the great German empire. It was a befitting time to raise substantial memorials, and monuments have been erected to the memory of Emperor William in all parts of Germany. Many of these monuments are large and magnificent, and we have already published quite a number of them in the pages of the SCIENTIFIC AMERICAN and SUPPLEMENT. We take pleasure in presenting to our readers two imposing monuments which have recently been dedicated to the public.

Of the two, one is at Magdeburg, the other at Coblenz. Thus each represents a different style of work, as a glance at our illustrations will prove. The Magdeburg monument, which was unveiled on August 25, was designed by Herr Rudolf Siemering and is distinguished mainly by its tasteful simplicity. It has been placed on the main square of the northern part of the city, outside the old fortifications. The site is very favorable, the background of the monument being very appropriately occupied by a fine building.

The erection of a monument to the old emperor by the city of Magdeburg was planned very soon after his death, as early as the 24th of March, 1888 (William I died on the 9th of the same month). Three months after, on the 19th of June, voluntary contributors placed in the hands of the committee formed in connection with the enterprise a sum of $50,000. Siemering was requested to hand in plans for a suitable monument. He complied, and, his design being approved of, the execution of the work was committed to his charge. The site chosen was at the time as yet free from buildings, but it was hoped that before the completion of the monument suitable surroundings would have grown up. And this hope we see was realized.

As regards the monument itself, certainly its most striking element is simplicity. The absence of a great number of details of secondary or, at any rate, only ornamental importance results in a concentration of the attention of the beholder on the main figure, Emperor William the First, arrayed in his uniform and mounted on a noble steed. The arms of the German empire, those of the city of Magdeburg, and a simple dedication on each side, are the only decorations which the artist has given to the pedestal.

The dimensions of the various parts we extract from Ueber Land und Meer, to which publication we are also indebted for our cuts. The length of the pedestal, measured at the height of the inscription, is 13 feet, the breadth at the same height is 4 feet 6 inches. The ascending stairs, which form a base, are 32 feet by 26. The point of the emperor's helmet is 32 feet above the level of the street; the statue, with the horse, measures 15 feet in height.

The effect of the whole is completed by a relief which runs across from left to right at the back of the monument. This relief has an interesting history. It was modeled by the artist in 1870 at the time of the calling out of the army, and produced quite a sensation at the time. But it was never until the present occasion worked out in stone. There it now stands, reminding the nation of one of the greatest events in her history during the reign of the great emperor.

The statue was cast by the Lauchhammer Iron Foundry, of an alloy of aluminum, tin and copper. The granite was shaped by the firm Kessel & Röhl, of Berlin, the stone being the brownish red Wanewyk granite from Sweden. The platform surrounding the pedestal is inlaid with a mosaic by Rudolf Leistner.

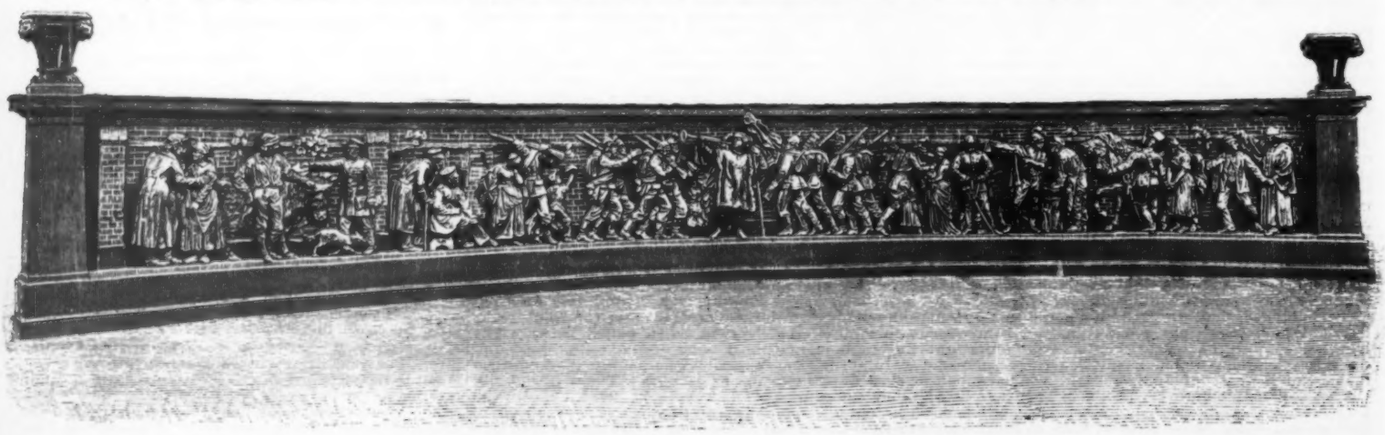
To turn to the Coblenz monument, we find in it altogether another style of work. A massive architectural pedestal raises the figures aloft, and as the monument stands on the peninsula formed by the junction of the Rhine and the Moselle, a very fine distant view across the water is obtained from several points. In details also this monument differs considerably from the one at Magdeburg. The figures, of which there are two, are placed immediately on the architectural base. This latter is a large square structure, to which flights of steps ascend from all sides. It is made of large stones and consists of two parts, one a raised platform, around the sides of which runs the inscription, "Wilhelm dem Grossen;" the other, the pedestal proper, consisting of a number of low and massive columns. Those which form the corners are more massive yet than the others and bear decorative shields. Below the inscription "Kaiser Wilhelm dem Grossen" is a relief representing an eagle spreading his wings in protection over a crowd of men fleeing from a hydra.

The statues stand on a level 94 feet above the river, and the equestrian statue of the emperor is 45 feet high. The other, a winged allegorical figure, bearing the laurel wreathed imperial crown, is 30 feet high.

The statues were cast by A. Rinkleben, of Brunswick, according to a design by Hundrieser & Schmitz. The stone is partly granite from the Black Forest and partly basalt. The total expenses of the erection of the monument, amounting to $375,000, were covered by the surplus of interest of the Landes Bank.

These two monuments are a fitting tribute paid by two important German cities to the memory of the emperor under whose rule the ancient realm regained by the sword its former power, to settle into a time of peace and prosperity.

THE EMPEROR WILLIAM MONUMENT AT MAGDEBURG.



RELIEFS ON THE EMPEROR WILLIAM MONUMENT.

TREATMENT OF LOW GRADE ORES BY CONCENTRATION.

THE above is the title of a paper read by E. B. Kirby, of Denver, Col., at the recent meeting of the International Gold Mining Convention in that city. The following is a condensation of the article:

It is well understood that most ores of the precious metals are composed of rock with mineral crystals distributed through it. Those minerals present in any particular ore may comprise one of several out of a large list. As a matter of fact, there are four which are so common and prevail so universally in mining districts that few mills have to deal with any others. These minerals named in order of frequency with which they occur are pyrite (iron sulphide), blende (zinc sulphide), galena (lead sulphide), and chalcopyrite (copper and iron sulphide).

Each of these minerals may contain both gold and silver, but pyrite and chalcopyrite are the common carriers of gold, while galena and blende have a special affinity for silver. It is also well known that in unoxidized or sulphide ores the gold and silver contents are not distributed uniformly through the mass, but are generally confined to these mineral crystals. By crushing the ore and separating out the valuable crystals from the waste material or gangue its value is concentrated into their small bulk. This will bear the expense of shipping and smelting or of treatment by the more expensive processes.

Concentration milling is, therefore, the most important of all processes applied to low grade gold and silver ores. It is of the same fundamental importance here as in the field of simple lead, copper and zinc ores. It is of more general application than any other process, and by one simple treatment, performed at the mine, it gets rid of the mass of valueless gangue. The cost ranges from 20 cents to $1.50 per ton, according to the capacity of the mill and the system employed. It is, therefore, the cheapest of all processes, with the single exception of free gold stamp amalgamation, which costs from 35 cents to $1.25 per ton and produces a product in the form of bullion which requires no further treatment. The more expensive processes of pan amalgamation, barrel chlorination, cyanide and smelting entail an expense per ton of ore which greatly exceeds that of concentration. The latter will always maintain its superiority in cheapness, and also in its range of application. The other processes find their special field in the treatment of concentrates, or of high grade ore, or of ores which are of exceptional character, and do not yield their values to the simple operation of concentration or free milling. The gold ores of Mercur, or of Cripple Creek, or the quartzite ores of the Black Hills, together with the oxidized lead and heavy sulphide ores of various districts, are illustrations of the latter class.

Before mining men it is unnecessary to dwell upon the extent of our resources in low grade ores of gold and silver. All realize the opportunities they present for the future application of capital. The majority of these ores can be utilized only by concentration milling. As costs lower and extraction improves they will be gradually brought into use. But the extreme economies in mining and milling can only be secured by operating with modern skill upon a very large scale, and this requires a large capital. Hence, these resources are not waiting for the invention of some new and magic process. The process is already at hand. According to the skill and capital with which it is applied, it can now be made to yield almost any results within reason.

The more recent processes, like barrel chlorination and cyanide, together with their various modifications, have developed so rapidly within a few years that they have attracted great attention. Much has been written and published about them, and the mining world is already well informed upon the latest methods, results and costs of each one. Concentration, although of more importance and more widely applied, has not progressed in such a startling way. The general mining public have, therefore, had less information upon its present development.

In crushing ore for the process, it must be broken fine enough to free the mineral crystals from the gangue. For most ores the size necessary for this purpose is quite small, so that the crushing unavoidably produces a large percentage of flour or slime. Moreover, this slime generally contains the richest minerals present in the ore, because these are more soft and pliable than the quartz. Slime requires the most elaborate and expensive machinery for its treatment. It has to be handled more slowly and is subject to heavier losses than grains of larger size.

The problem always presented, therefore, is how to crush so as to liberate all the mineral, but at the same time to avoid a large slime production.

These objects are secured by making use of one or both of the two following methods:

1. The ore is subjected to an operation of part crushing, which is repeated several times. After each operation the grains which are small enough are sifted out.

2. The ore is crushed to a size somewhat larger than that necessary to liberate all the included material, and the oversized grains are then subjected to a rough concentration on jigs. This takes out the liberated mineral and thus promptly withdraws most of the values from the danger of further crushing. The impoverished grains are then crushed again to the proper size and concentrated.

Each of these methods calls for a more complicated and expensive crushing plant. How far their advantages outweigh the cheapness and simplicity of crushing to the final size in a single operation is always a question for calculation and experienced judgment. In general it is to be noted that American mills differ from those of Europe in showing a marked preference for the more simple plan.

The grains of the crushed mass range in size from the crushing limit of, say, ¼ in. diameter down to microscopic flour. They possess two properties, and only two, upon which it is possible to operate. These properties are size and specific gravity. It is, therefore, necessary to operate first on one and then on the other. Strictly speaking, it is impossible to effect any separation by acting upon both at the same time. For instance, a grain of pyrites is heavier than quartz, if the two grains are of the same size, and it will therefore fall more quickly in water. But it is not heavier than a very large quartz grain, and, if two such unequal grains fall together, the quartz will fall more rapidly.

Hence, in order to make a separation, it is always necessary to perform two distinct operations in succes-

INAUGURATION OF THE EMPEROR WILLIAM MONUMENT AT COBLENZ.

sion upon the crushed grains. The order adopted is not an essential matter, and concentration is therefore effected either by sizing and then sorting or, on the other hand, by first sorting and then sizing. According to one plan, the grains are first divided into a number of different sizes. Each size is then subjected to the sorting effect of a fall in water, which separates all the quick falling mineral grains from the slow falling rock.

By the reverse method the grains are first sorted into a number of classes, each of which includes those grains which fall in water at the same velocity. It takes a large grain of the light quartz to fall at the same speed as a small grain of the heavy pyrites; so that in each equal falling class the quartz grains are all of larger size than the pyrites grains. The subsequent operation of sizing, performed on each class, separates the large grains from the small ones and completes the concentration.

These well known principles are simple enough and the two operations required do not seem difficult. Nevertheless, there is a great variety in the machinery and apparatus for performing each one. In practice the work of a concentrating mill is rarely confined to these two simple operations. It is complicated in various ways. If one operation is not done well, those which follow it suffer. Imperfect work, therefore, often makes it necessary to repeat the series. There is a large class of grains in which the crushing has failed to break the mineral from the rock. The grain, therefore, has an intermediate specific gravity and does not find its proper place. Other grains have peculiar shapes, which alter their rate of fall in water. Such middling products must be provided for and require special treatment. Most ores are more difficult than the simple case of quartz and pyrites. The differences in specific gravity are slight, or it may be necessary to separate several minerals not only from the gangue, but also from each other.

For the operation of sizing grains, screens are naturally employed whenever it is possible to use them. In practice screens do not work well on grains smaller than coarse sand. Inclined plane sizing machines are, therefore, used for all fine material.

Machines of this class have an inclined plane over which a very thin sheet or film of water is made to flow. This sheet of water is only one-twentieth of an inch thick and moves most rapidly at its upper surface. At the bottom, where it is in contact with the inclined plane, the water flows more slowly on account of friction. When grains of different size are treated, the large grains, resting on the inclined plane, reach into the quick moving part of the stream and are rolled down the slope. The small grains lying in the slow moving region, close to the bottom, roll more slowly or not at all. The small grains which thus remain upon the inclined surface are either allowed to accumulate, as in hand or intermittent buddles of all kinds, or they are removed automatically by various methods. In one class of machines percussion or jerking movements are applied to the table. They cause the deposited grains to crawl out of the way and thus discharge themselves. In revolving buddle and belt machines the surface itself moves slowly from under the depositing current and thus carries its deposit to the discharging point.

All these appliances, when used according to the scientific principles of concentration, are sizing machines, and the grains which deposit upon them do so because of their smaller size, and not because of their greater specific gravity. In order to secure good results from them it is, therefore, necessary to treat only grains which are equal in falling and in which the mineral grains are consequently all smaller than those of the rock. It follows that they cannot do good work unless the preliminary sorting has been well done.

The second fundamental operation of sorting is performed either by hydraulic classifiers or by jigs. There are two leading varieties of hydraulic classifiers. Those of one kind sort by allowing the grains to fall in a deep on-flowing stream of water. This deposits the quick-falling grains near its head and carries the slow-settling grains further on. Each class of grains is, therefore, deposited at a different point. Another type of classifiers subjects the grains to a series of rising currents of different velocity. Each of these is adjusted so that grains of a certain falling speed will sink through it while the others are carried on.

The jig, though a simple machine, is remarkably efficient; and, unlike classifiers, it does its work very perfectly. It is most remarkable for the fact that, like a jack knife, it can be applied to a variety of uses. It will either sort or size, according to the way it is used. Moreover, it can be made to do good sorting on grains which vary greatly in size. The complex laws of jig action have been the subject of elaborate scientific investigations which are not within the province of the limits of this paper. The greatest American improvements in concentration, however, are based upon certain methods of utilizing jigs. It is, therefore, necessary to refer briefly to the main features of their action.

Mining men are familiar enough with the machine itself, which, in its present form, is very simple. Two to four flat stationary sieves, arranged in a row, are partly submerged in a box or tank of water. The stream which conveys the grains to be jigged is led upon the first sieve of the series and flows along the row to the point of discharge. By means of large pistons applied to the water in the box, it is caused to pulsate or rise up and down in rapid succession through the apertures of the sieves. At each pulsation the entire mass of grains resting upon the sieve is suddenly lifted up a short distance by the water, and is then allowed to fall back upon the sieve. The more rapid falling grains gain a little upon the others during each fall, and finally reach the bottom of the mass. Grains too large to pass the sieve accumulate upon it and are discharged by simple devices. Small grains which pass through the sieve fall into the body or "hutch" of the jig and are drawn off below as "hutchwork." The slow-falling grains accumulate at the top of the mass and are carried off by the onflowing stream. For some purposes it is necessary to have the water sink down again after each lift. The fast-falling grains are thus drawn down more rapidly by its quick suction. For other work this down suction is injurious. The machine is then so arranged that it will merely give a series of sharp lifts, after each of which the water either falls back slowly or remains stationary.

The jig is applied to three classes of work:

1. It is used to sort grains of the same size, and in this case each jig is fed with one of the sizes produced by the screening apparatus. When such equal sized grains are jigged, the quick-falling mineral grains promptly descend to the bottom of the mass.

2. It is used to size the grains of an equal falling class which are delivered to it from a hydraulic classifier. In order to accomplish this work each sieve is provided with a permanent bed or layer composed of large grains of heavy mineral. The interstices between these large grains have much the same effect as a sieve. The small or mineral grains descend through them against the rising currents and finally pass into the hutch.

In the German system of concentration the use of jigs is restricted to the two aforesaid operations. There is, however, a third way of using jigs known as the English method of jigging. This is because it was most extensively practiced in the mining districts of Great Britain and attracted attention because of the remarkable results of the old fashioned hand jig. American practice has taken up and improved this method of jigging and made it the basis for one of the most efficient modern systems of concentration.

In this method the jig is not fed with grains which have been previously either sized or sorted. On the contrary, it treats the entire mass of material just as it comes from the crushing machinery, and includes grains of all sizes and all specific gravities. A heavy bed of coarse grains is kept upon each sieve and the water pulsations are arranged so as to give a downward suction after each lift. It is found that those grains which are too large to penetrate the interstices of the bed are near enough to the same size to separate very well upon it. The sands and slimes which do enter the interstices are subjected to peculiar laws of fall and of suction which prevail in such restricted channels. The result is that the mineral grains of greatest specific gravity pass through into the hutch, while the others are driven back and carried off in the tailings. The action of currents in these interstitial spaces has a very singular effect. They lessen the influence which differences in grain size usually have upon their falling speed. In consequence it becomes possible to thus operate at once upon the specific gravity of grains which differ very greatly in size. The very finest slime, however, cannot be concentrated in this way, and must be separated and treated by the usual methods.

The hutchwork concentrates which have been made with such an apparent disregard of size are not very clean, and require another treatment in order to yield a pure product. This is done by the simple plan of repeating the same operation with some slight differences in its details. The impure hutchwork from the roughing jigs is delivered continuously to finishing jigs placed at a lower level. These complete the work and produce clean concentrates.

But one class of machinery remains for consideration, and this is important, because it has found its chief use in the stamp mills of the West. It is, therefore, the basis for what might be termed the stamp mill system of concentration. This class includes vanners, pumping tables, and shaking and jerking tables, of many designs. They are intended to treat only finely crushed material like sand and slime. They do excellent work on assorted grains. Moreover, they do not perform a single fundamental operation, like sizing or sorting. On the contrary, each machine performs two operations in succession, one of which might be termed "settling," while the other is an imperfect zigzag, generally called "washing." Machines of this class maintain a flat, shallow stream of water, which flows down an inclined surface. This stream is not a thin sheet or film, as in the zigzag machine previously described, but it is from one-half to three-fourths of an inch thick. The crushed material is generally treated as it comes from the stamps and without any preliminary sorting. As the grains settle out of the stream, they are prevented from packing and are kept in a semifluid condition by shaking, bumping or jerking movements imparted to the inclined surface. The effect is rather complicated. The quick-falling grains, whether large or small, tend to work to the bottom of the mass, while the small grains tend to sift down through the interstices of the larger ones.

There is no clear or definite separation, but as a final result most of the mineral grains sink beneath the top layer and accumulate near the bottom. This enriched bottom layer is gradually drawn out from under the settling stream. This is effected either by the gradual travel of the surface or belt, as it vanners, or by the crawling action of the grains themselves, caused by the bumps or jerks. The concentrates thus produced by this "settling" operation are impure and have to be cleansed by "washing." This is done on the same machine just before discharge, generally by a thin sheet of water applied in jets. The precise effect of this "washing" varies with the movement and the surface used, and is too complex for analysis here. In most cases it is a quick and imperfect sizing. Although each of the aforesaid operations is imperfect in itself, the two in succession effect a very satisfactory concentration upon fine crushed and unsorted grains.

When machines of this class are fed with equal falling grains produced by a hydraulic classifier, they then become very efficient sizing machines and the concentration is greatly improved. When acting upon sorted grains, the settling operation causes the small grains to work through and under the large ones. The final quick washing by a thin sheet of water upon the inclined plane of the machine is, of course, a sizing action, and in this case it is not complicated by the presence of unsorted grains. Vanners, which are the best known of these machines, have found an extensive use for treating sorted grains in complete concentrating mills.

Gold and silver stamp mills operate upon ore which contains either free gold or silver in forms which will yield to the process of amalgamation with mercury. But very few ores found at the present time are strictly free milling, and as a rule part of the values are contained in sulphide crystals. It is, therefore, generally necessary to supplement amalgamation by the concentration process.

Amalgamations require very fine crushing, and therefore furnishes material very difficult to concentrate. Moreover, there are many stamp mills which are designed solely for concentration, in which this fine crushing has been adopted because the minerals are finely disseminated through the ore. When such fine material is to be concentrated, the standard German system for treating sands and slimes, if properly designed, will generally secure the best extraction. At Western mills, however, simplicity of plant is a very important matter. The general preference is, therefore, for machines of the class just described, which have the advantage of giving good working results on unsorted or poorly sorted material.

In many cases this desire for simplicity has been carried too far. These machines save more and have greater capacity when they are fed with properly sorted grains. To introduce hydraulic classifiers in a mill causes some complications, particularly when the mill has not been built for their use. The plant also requires more attention and skill. There are few cases, however, when the increased saving will not more than offset these disadvantages. When hydraulic classifiers are adopted, it then becomes a question whether the standard German sizing machines are not best for these sorted grains. Here opinions differ. Rittinger percussion tables, belt percussion tables and revolving buddles now become rivals of the Western vanners, bumping and shaking tables. It may be well to observe that upon most sorted grains both classes of machines do good work. In treating the very finest slime, however, the inclined plane sizing machines, when properly adjusted, appear to have the advantage.

In reviewing the standard machinery and operations of the process, the Missouri and the stamp mill systems have been described. The other two are now easily understood.

The German system is the one most generally used, even in this country. In this system all large grains are first carefully sized by screens. Each of the many sizes is then sorted on a jig. The smaller grains, from sand size down, are, on the contrary, treated by reversing these operations. They are first sorted by hydraulic classifiers, and each class is then treated in a sizing machine designed for it. Those classes which include the large sands are put through jigs, which are operated as to size, instead of sorting the grains. The fine sand and slime classes are treated upon the standard inclined plane sizing machines, such as Rittinger percussion tables, continuous belt percussion tables and revolving buddles.

The German system requires a complicated plant, which has a comparatively small tonnage for the money invested. The cost per ton is also great, but against these faults it presents the advantage of effecting a closer saving than other systems. It is also preferred for difficult work; when the differences in specific gravity are slight, or when several minerals have to be separated, not only from the gangue, but also from each other.

The Lake Superior system was evolved to treat great quantities of ore with a more simple plant. The ore is crushed by steam plants, each head having a capacity of 300 tons daily. The grains, both large and small, are at once sorted into equal falling classes by hydraulic classifiers. Without entering into the peculiar details of Lake Superior jigging, it is sufficient to say that each class of large grains is put through a jig, whose principal function is sizing. This action is complicated somewhat on account of the fact that the preliminary sorting is not very perfect. The concentrates discharged from the hutches of these first jigs are not all pure. Some of the hutchwork is therefore treated again upon finishing jigs set at a lower level. The fine slime and sand classes are sized on revolving buddles, as in the German system. In some mills the hutchwork from the roughing jigs is sorted by hydraulic classifiers before it goes to the finishing jigs.

The mill of the Calumet and Hecla mine has a capacity of 6,000 tons of ore per day, and the cost is under 20 cents per ton. This system has also supplanted the German at the copper silver mines of the Anaconda Company in Montana and also at the Butte reduction works. The Anaconda concentrating plant has a capacity of 6,000 to 7,000 tons daily.

This system, together with that used in the Missouri lead and zinc regions, is specially adapted to ores which concentrate easily and do not require fine crushing. Constant improvements are being made in their efficiency, and on suitable ores they may yet rival the German system in close savings. It is impossible to discuss the numerous technical points which determine the question of choice, but it is well to call attention to the fact that the Missouri system is specially adapted to many gold and silver ores of the West. It is, therefore, sure to find a more extended use in this field. A plant of the most simple description applied to suitable ores will give satisfactory results. Through the Missouri mining districts numerous cheap but money making mills may be seen which include only a crushing plant and two to four jigs.

Irrespective of the system used, there is a radical distinction between American and European mills in the fact that the latter are intended to save all that is possible out of an ore. There is plenty of capital for elaborate and expensive plants, which will accomplish this purpose, and they are not run at the high pressure which prevails here. American mills are built for a different purpose. In our mining regions capital is scarce, while there is a superabundance of ore. The problem presented is always how to make money most rapidly out of the limited amount of capital which happens to be at hand for mill building. In general, it is most profitable to handle a large tonnage at the sacrifice of close savings, and mills are therefore arranged for this purpose. Even when designed to extract a high percentage of values, it is afterward generally found best to crowd the machinery beyond its normal capacity, at the sacrifice of its efficiency.

Generally speaking, therefore, the tailings losses of well designed American mills do not result from any lack of knowledge or skill. The principal losses occur in two ways: In the mineral crystals which remain included in the coarse grains and in the imperfect concentration of the fine sand and slimes. The first loss can only be remedied by recrushing and reconcentrating the coarse jig tailings. The second loss may be prevented by the use of more elaborate machinery for treating the fine material. Each remedy calls for more capital, and, when this is available, it is generally found better to use it for increasing the entire mill capacity, instead of perfecting these details.

In conclusion, it may be said that the selection of the

best system for any particular ore, and the question of how elaborate and perfect the mill shall be, are matters which call for careful judgment. Any error here results in a failure to secure the best paying mill for the money invested. Moreover, in no process is it so necessary to fit the mill to the ore. No two ores break alike or require the same outfit of machinery in each department of the mill. The selection and arrangement of machines and apparatus, the percentage which will be saved and technical details too numerous to mention all depend on the special character of the ore. In modern mill designs all these metallurgical questions are settled before building, and both the results and the cost of a mill may be known as accurately beforehand as in the case of any ordinary factory.—Mining and Scientific Press.

"HUMANIZED" MILK.

ITS COMPOSITION AND METHOD OF PRODUCTION, ERRORS TO BE AVOIDED, USEFUL INFORMATION ON THE VARIOUS PHASES OF AN IMPORTANT SUBJECT.

By HAROLD STACEY, Ph.G.

IN view of the fact that it has of late frequently been suggested that the pharmacist might with advantage prepare an artificial humanized milk for infants, it seems advisable to briefly review the literature on the subject and suggest working formulæ for those pharmacists who care to take up this subject.

CONSTITUENTS OF COW'S AND HUMAN MILK.

In the first place it is necessary to know the average composition of human milk and that of the cow, the latter of which is to be "humanized." The following table, based on analyses by J. Konig, shows the average composition of the two fluids:

	Human.	Cow.
Water	87·41	87·17
Casein	1·03	3·02
Albumen	1·26	0·53
Fat	3·78	3·69
Milk sugar	6·21	4·88
Ash	0·31	0·71

The table shows that in order to humanize cow's milk it is necessary to increase the amount of milk sugar, decrease that of the casein and albumen (these two bodies being usually tabulated together as "casein" or "albuminous constituents"), and at the same time maintain the amount of fat in statu quo.

THE PROCESS.

This may be accomplished in two ways, either by removing the casein by means of rennet and adding milk sugar or by diluting the milk with water and adding the requisite amount of fat and sugar to the diluted milk. The first method, while yielding a finer product, is not adapted to commercial ends, owing to the length of time necessary for preparation and to the expense attendant. The process is briefly as follows:

Take one pint of milk, from which the cream has been removed, and add sufficient rennet to precipitate the casein. Remove the curd, and in the whey dissolve 280 grains of milk sugar, and add this solution to two pints of new milk, subsequently adding the cream which had been removed. In this way a milk is obtained which has the following composition:

Water	87·17
Casein and albumen	2·37
Fat	3·69
Milk sugar	6·21
Ash	0·71

It will be noticed that this resembles very closely human milk in composition, the casein having been reduced one-third and the milk sugar increased from 4·88 to 6·21 per cent., while the amount of fat has remained unchanged. A simpler and in some ways more satisfactory method of reducing the percentage of casein is by dilution of the milk with water, the diminution in the percentage of fat being afterward made up by addition of fresh cream or butter. It is claimed that by diluting the milk with water it is altered in such a way that the casein coagulates in a similar manner to human milk, the coagulum of the latter being looser and more flocculent than that formed from cow's milk under ordinary conditions.

WORKING FORMULAS.

To reduce the content of casein in cow's milk to the same percentage as that of human milk, it is necessary to add three parts of water to every five parts of milk. The fat and milk sugar are naturally diminished, and the requisite percentage must be made up by addition of more milk sugar and fat. The latter is added either in the form of cream or butter, preferably the latter, owing to its more constant composition. It is readily emulsified by the milk. The following forms a good working formula:

New milk	2 pints.
Fresh butter	3 drachms.
Milk sugar	500 grains.
Water	19 ounces.

Dissolve the milk sugar in the water and add to the milk and butter previously emulsified. If cream be used, the following formula, given by Clague, will be found to work well:

New milk	3 ounces.
Cream	1¾ ounces.
Milk sugar	1½ ounces.
Water	18 ounces.

Mix secundum artem.

TO MAKE UP THE DEFICIENCY IN FAT.

Soxhlet objects to the addition of fat to the diluted milk, and suggests that additional milk sugar be added to make up for the deficiency in fat. He states that milk containing an abnormal amount of fat cannot be sterilized without the fat becoming partially separated, and the state of emulsion so necessary to assimilation being disturbed. All the functions performed by fat are equally well performed by carbohydrate material, and to make up the deficiency in fat an isodynamic amount of milk sugar must be added to the diluted milk. According to Rubners, 243 parts of milk sugar are isodynamic with 100 parts of fat; consequently, a deficiency of 1·32 per cent. of fat may be made good by an addition of 3·19 per cent. of milk sugar. Soxhlet, therefore, advocates a milk preparation as follows: Prepare a solution of milk sugar in water of the strength of 12·3 per cent., and to every two parts of milk add one part of this solution. The resulting fluid will have this composition:

Water	85·30
Casein	2·37
Fat	2·46
Milk sugar	9·41
Ash	0·47

Such a milk possesses all the nutritive properties of human milk, is readily prepared and does away with all troublesome additions. Moreover, it coagulates in a very similar manner to human milk—a matter of the very greatest importance in infant feeding.

MINERAL CONSTITUENTS OF HUMANIZED MILK.

In the preparation of all of these "humanized milks," no mention has yet been made of the mineral constituents. This is of sufficient importance to warrant special attention. Human milk is alkaline to litmus, containing only one-sixth of the amount of lime present in cow's milk and only about one third of the amount of acid phosphates. It is very important to correct this excess of acidity and mineral salts in preparing humanized from cow's milk. This may be best accomplished by addition of sodium bicarbonate. This alkali is preferable to lime water, as cow's milk already contains an excess of lime salts. The amount necessary for neutralization of the excess of acid salts is six grains to the pint. This addition should be made after the process of sterilization. Dr. A. E. Wright has advocated removal of part of the excess of lime salts present in cow's milk on the ground that the coagulum formed is less dense in proportion to the diminution in lime salts present. He advocated the addition to the milk of a small amount of sodium citrate. In the proportion of one part to 200 parts of milk, he finds that sodium citrate prevents any coagulation by rennet, and the addition cannot be readily detected by the palate. A much smaller proportion is sufficient to "humanize" cow's milk.

THE OBJECTION TO STARCH.

Attention may be directed here to the fact that certain writers on this subject have advised the addition to these artificial milks of various forms of carbohydrate food, such as oatmeal flour or decoction, arrowroot, barley water, and even meat broths of various kinds. Such additions can only be deprecated, seeing that the saliva of infants does not contain any ferment capable of converting starch into sugar or other assimilable form. Milk sugar is the only carbohydrate found in the milk of any animal, and if additional carbohydrate food is needed, it can best be supplied by increasing the amount of this constituent.

CONDENSED MILK AS INFANTS' FOOD.

A word must be said as to the use of condensed milks for infants' food. For many reasons these milks are not to be recommended. The processes which they are put through in their manufacture lead to considerable alteration in the character of the fluid. The casein becomes less readily precipitable and is less readily digested. Changes also occur in the character of the albumen, which is generally coagulated; the percentage of milk sugar is somewhat reduced and the fat is thrown out of its emulsified state to a greater or less extent in various brands. As a rule a portion of the fat is removed before concentration. More important than this is the probable destruction of the natural germicidal properties of the fresh milk and of its natural ferment.

The variation in composition is well shown by comparing the results here given of analyses of various brands:

	Water.	Casein.	Fat.	Milk sugar.	Ash.
1	56·71	13·18	14·13	13·98	2·00
2	55·43	14·00	13·16	14·84	2·53
3	56·01	13·90	14·02	14·06	2·01
4	52·07	14·26	15·06	16·97	2·80
5	57·96	8·50	16·02	16·32	2·20
6	51·72	11·09	14·33	19·51	2·75

(These brands were all unsweetened.)

It is impossible, where such variations in composition exist, to give working formulæ for humanizing the commercial condensed milk.

THE QUESTION OF STERILIZATION.

Of considerable importance in connection with preparation of humanized milks is the question of sterilization. So much has been written on this subject that more than a summary of the result arrived at is unnecessary. A valuable paper on this subject is that by Dr. Albert Leeds and Prof. Conn in the report of the Dairy Commission of the State of New Jersey for 1892 on the "Preservation of Milk," to which those interested are referred. After what has been said on the subject of condensed milks, it will suffice to say that a boiling temperature for sterilizing milk is highly undesirable, and experiments have shown that the most satisfactory method of preserving such milks is by the method of Pasteurization. By keeping the temperature below 70° C. (158° F.) the natural properties of the milk are but little affected, while the above temperature or a few degrees below will suffice to kill all pathogenic organisms likely to be present in milk. Preservatives are not recommended for addition to humanized milk, and in particular the use of formaldehyde to preserve milks intended for infant use should be condemned. This agent, even in minute amounts, has a most injurious action on the mucous membranes, converting them, if the action is constant, into a substance closely resembling leather and setting up severe irritation. Given to infants in milk, its action on the coats of the stomach cannot be other than injurious, even in the minutest amounts, and when used for this purpose may possibly prove to be the forerunner of lifelong dyspepsia.—American Druggist.

PRODUCTION OF COPPER PLATE VARNISHES.

FOR copper print varnishes, which must be still stronger than lithographic varnishes, old linseed oil or preferably nut oil is used; the latter is never employed alone, but mixed with linseed oil to give it more viscosity. According to the product desired, 12 to 50 per cent. of linseed oil is added.

The process of manufacture, as it is performed up to the present day, consists in heating the oil in a vessel holding about 25 liters, until it flashes or gives off white fumes that may be ignited. The oil is allowed to burn for five minutes, the vessel removed from the fire and placed upon a pile of ashes, where burning is allowed to continue for a few minutes more. Then slices of bread are put in the oil, one after the other, and each is left in until it has become brown, but not burnt; onions are also said to be employed. In practice this operation, which seems to be necessary, although no explanation can be had for it, is designated the "degraissage" of the oil. Now the vessel is covered and allowed to cool off, and a clear greenish oil, a little thicker than linseed oil, is received

To obtain a thick (strong) oil, the oil when still showing the necessary heat is again lighted and allowed to burn five to ten minutes, stirring repeatedly, extinguishing the flame and lighting it again, and repeating this twice, sometimes even three to four times. The cooled oil draws threads like sirup. The grade called "huile grasse" is of inferior consistency, and is only lighted three times during its preparation.

In large works, however, this mode of production is no longer in use; the degraissage with bread has been supplanted by one with nitric acid or magnesia; the latter, mostly employed in England, is carried out by adding 2 per cent. of magnesia to the oil, leaving it to boil one hour, then pouring off or allowing to cool.

The oil is gradually heated to 180° C. in a kettle containing about 200 liters and is kept at this temperature for three hours. Then 500 grammes of finely pulverized bichromate of potash are added and the temperature raised to 300° C., a rising of the oil being prevented by pouring in small quantities of cold oil. After the temperature has been increased to 315°–320° C. during half an hour, 500 grammes Paris blue are still added. Now it is allowed to cool and thus the strong varnish ("huile forte") is obtained.

To produce "huile grasse," the temperature is maintained at 300° to 305° C. for only five minutes; for "huile claire," the temperature must not exceed 275° C., at which it is kept fifteen to thirty minutes, according to the purpose desired.

Villon gives the following proportions for the preparation of a fine copper plate printing ink (Frankfort black): 1,000 parts "huile claire," 250 parts "huile forte," 500 parts lampblack, 50 parts Paris blue, 25 parts resin soap.

The Paris blue and the "huile claire" are exposed, in a kettle provided with a stirrer and a double bottom, which can be heated by steam, to a temperature of 100° C.; the latter is then increased to 150° and the resin soap added, stirring incessantly. After the cooling, the lampblack and then the "huile forte" are added in a mixing machine and finely ground in a cylinder color grinder. For a less careful manufacture a common paint mill is sufficient.

Villon, who has made numerous researches, in order to obtain a copper printing ink of a deep black without a reddish tint, and which will keep well, has finally adopted the following composition, each ingredient of which has its significance: 1,000 parts huile claire, 200 parts huile forte, 23 parts carnauba wax, 35 parts paraffine, 25 parts resin soap, 4 parts violette de Paris, 40 parts Paris blue, 100 parts noir de Liège, 50 parts blutkohle (bloodcoal), 200 parts noir de lie, 150 parts boneblack.

A good many other substances, such as Canada balsam, ceresine, asphaltum, stearic acid, ozokerite, Japanese wax, have been proposed, to impart the necessary consistency to the composition.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from the Färben Zeitung.

THE FUTURE OF PHOTOGRAPHY IN ITS APPLICATION TO MEDICINE.

PHOTOGRAPHY has come so rapidly forward of recent years as an aid to our senses, and in materially increasing the value of our observations, that no apology is needed for pointing out briefly the advantages which the practical study of the art would afford the medical student. The extremely sensitive photographic film only illustrates, after all, how dull is the perceptive power of the eye, and how far short of perfection it falls, considered in the light of an optical instrument. In recommending the student to practice photography we do not do so with any wish to burden him with another subject in his already crowded curriculum. We rather enjoin him to acquire a practical knowledge of photography because it tends to sharpen his powers of observation, to lead him to make faithful records, and to cultivate in him the artistic method. Indeed, we suggest it as a pleasant, instructive and recreative pursuit, and in these days of dry and rapid plates and of cheap yet good apparatus there is nothing so simple as taking a photograph and taking it well. Then, again, the student's recently acquired or freshened knowledge of chemistry will in no small measure enable him to obtain good results. At most medical schools now dark rooms are provided and other facilities afforded for taking photographs, since a knowledge of practical photography is found to be extremely useful in the dissecting room, in the post-mortem room, in the ward, and in the operating theater, while the capacity to take a micro-photograph is essential in the practical study of bacteriology and physiology. Even in these applications photography may be pursued as a hobby, but what a useful hobby! It is but a simple step from the photograph to the block picture used for illustrating published communications, and in describing cases of surgical or of general medical interest photography again and again proves an invaluable aid.

We go a step further than this, because the extreme sensitiveness of the photographic film has more recently laid bare certain phenomena which otherwise would probably to this date have remained unobserved. The phenomena we refer to are not interesting merely as

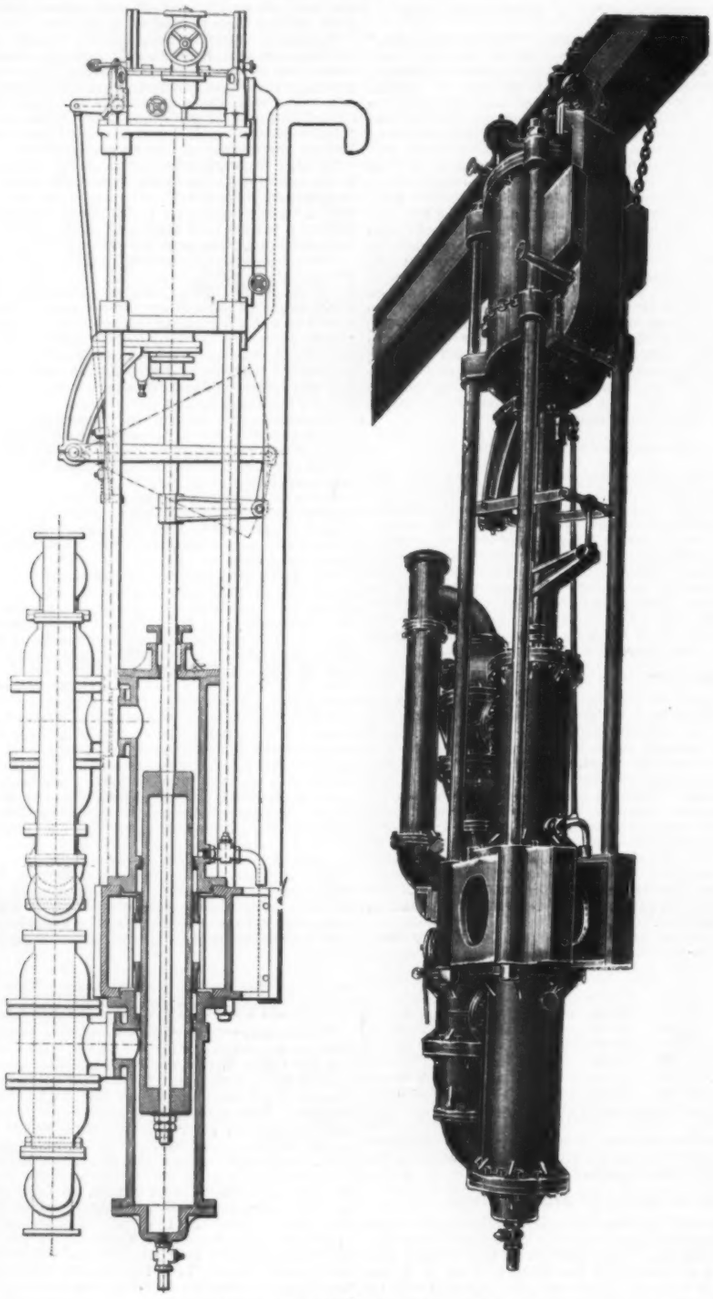
phenomena, but, as is now well known, they have led to a remarkable application of photography to the diagnosis of disease and to the discernment with more or less certainty of hidden anatomical abnormalities or even of pathological conditions. We refer to the X rays. In addition to a good sensitive plate, the student requires for this work a good induction coil and a vacuum tube, but the camera is no longer necessary. Indeed, for many purposes the sensitive plate may be dispensed with, since the rays may be made visible by means of the fluorescent screen. Examples of photographs showing the internal structure of the body, of the organs and the bones, or of hidden foreign bodies are now too familiar to need any further description. The discovery has brought to light one extremely important fact, namely, that there exist vibrations which are so rapid as to pass easily through what are otherwise opaque substances, and yet which fail to create an impression upon the optic nerve. But the sensitive plate reveals them, just as it records an infinitely greater number of stars than the eye is enabled by the best telescope to see. The demonstrated existence of such highly attenuated matter must have a profound influence upon our preconceived ideas of the nature of that mysterious thing, the elementary substance, or matter. Further, it has recently been shown that light or, at any rate, vibrations similar to it, are emitted by almost all substances. Perhaps the most remarkable example of this kind is afforded by uranium and its salts, which emit a peculiar kind of light which is dark to the eye, but which very distinctly affects the photographic plate. And, strangest thing of all, this property appears to be inexhaustible. Moreover, the radiations so obtained appear to be like the X rays, able to permeate such ordinary opaque substances as black paper, celluloid, etc.

Another most promising development in photography, and one which will probably have an important bearing on medicine, is the recently announced discovery of a process by which the objects photographed may be displayed in all the variety of their natural colors. It is quite evident that when the particulars of this process are made known, an additional means of great importance and value will be at the disposal of surgeons and physicians for making more exact pictorial records of surgical and anatomical cases and morbid specimens.—Lancet.

A LARGE SINKING PUMP.

THE accompanying illustrations represent a large sinking pump recently constructed by the Pulsometer Engineering Company, Limited, of Nine Elms Ironworks, London, for a mine abroad. It is on the well known Deane system, with some modifications in the details of the valve gear to suit the purpose in view.

The steam cylinder is 26 in. diameter, and has a stroke of 36 in. The pump, which is double acting, is of the plunger pattern, and is outside packed. It is 11 in. diameter by 36 in. stroke. The valve boxes, which are provided with hand doors, are made separately, and are fitted with multiple valves. The valves of the cylinder are placed above, and form part of the top cover, in place of on the side, as is the usual practice. Communication to the bottom end of the cylinder is by means of a separate casting, as shown by the cuts, and, in the event of breakage, the parts, being separate, are easily replaced. The valves are worked by the simple arrangement of rod and lever as shown. The pump barrels are held together by the center casting, to which the rods for hanging the whole pump and attachments are also fixed, the rods going up and through bosses on the cylinder and above to the slinging links and eyes. The pump boxes are fitted with gun metal grids, on which work the extra thick rubber valves with plates and buffers on the top to lessen shock. The sinking operations are much simplified by the sliding suction pipe supplied with the pump, and being partly constructed of the Pulsometer Engineering Company's union pipe, is light and strong, and well suited for sinking purposes. The total height of lift is 400 ft.—The Engineer.



DEANE SINKING PUMP.

The first notice of the use of coal is in the records of the Abbey of Petersborough, in the year 850 A. D., which mention an item of 12 carloads of "fossil fuel."

FIVE THOUSAND CANDLE POWER "EMERGENCY" LIGHT.

THE "Wells light" has now become so common, and proved so satisfactory, that surprise may be expressed at its makers bringing out another high candle power oil light working on a different principle. The new light, however, which we illustrate above, is not intended to replace the older one, but for use in circumstances where the 8 or 10 minutes needed for heating the vaporizer cannot be spared, as at fires, breakdowns, etc., where every minute of time becomes of serious import. The new lamp is a spray, and not a vapor lamp, and might accordingly be justly considered as

FIG. 1.

FIG. 2.

THE WELLS "EMERGENCY" LIGHT.

a case of atavism, as the first of all the high power oil lights was worked on this principle. As then constructed, however, the power required to produce the spray was considerable, while as now made by Messrs. A. C. Wells & Company, engineers, London and Manchester, a boy can easily maintain one of the lights in full activity. As shown in Fig. 1, the lamp consists of a reservoir containing oil, and fitted with an air pump, by means of which a pressure is maintained in the space above the oil. This pressure is then utilized to force the oil up to the burner in the usual way. At the same time, however, a second pipe coming from the top of the reservoir leads air to the sprayer, which completely breaks up and shatters the oil as it flows from the burner. A pilot light fitted with a wick is kept constantly burning, and immediately the cock shown on the standard is turned, the flame starts into full activity. Closing the cock puts out the flame instantly, so that the lamp can be used very conveniently for signaling purposes. The standard, with its oil and air tubes, can be completely detached from the air reservoir, the two tubes aforesaid passing into this reservoir through glands, as shown in the figure, which, on replacing the apparatus, only require tightening up for the lamp to be ready for use. The construction of the burner is shown in Fig. 2, which also exhibits clearly the position of the pilot light. The reservoir of the latter can be filled from the main one by opening the small valve shown at the back of the spray producer.—Engineering.

ELECTRIC CABS IN LONDON.

THE London Electrical Cab Company, some weeks ago, began to run fifteen electric cabs supplied by accumulators. We borrow an account of the arrangements adopted from our contemporary The Electrical Review.

FIG. 1.—THE LONDON ELECTRIC CAB.

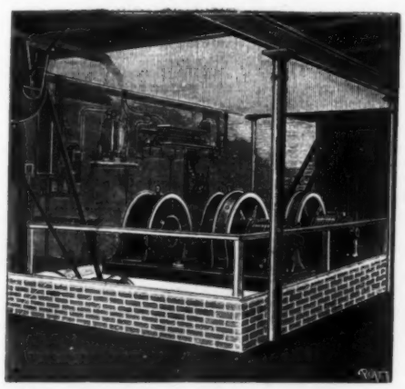


FIG. 2.—INSTALLATION OF THE MACHINES FOR CHARGING.

The vehicle, which is represented in Fig. 1, has the exact form of a coupe. The interior is tapestried, and at the side there are windows that can be opened and others that are fixed. The coachman sits in front. The battery employed consists of 40 accumulators of a capacity of 170 amperes hour with a discharge of 30 amperes. They are mounted in a box placed upon a support, which is suspended by means of springs beneath the cab. A 3 horse power Johnson-Lundell electric motor, with a doubly wound inductor and armature, is fixed in a box in the rear and actuates a transmission shaft through a train of gear wheels. This shaft is divided into two parts, each of which, through a chain, sets in motion one of the two hind wheels. The windings and the fields may in the first place be coupled in tension with a feeble resistance. This resistance may afterward be removed and the cab run at a speed of 2¾ miles an hour. With the armatures parallel and the fields in tension, 6¾ miles an hour may be made. Finally, with the two fields in quantity, the cab may be run at a speed of 8¾ miles an hour.

The accumulators have a total weight of 1,560 pounds, and the cab complete, inclusive of passengers, weighs 3,350 pounds.

Upon the left side is placed the starting lever. As soon as this is pushed forward, the cab starts off with a speed of from one mile to nine miles an hour. It suffices to reverse the lever and place it in the center in order to stop the cab at once. If the lever is pulled back, the motion of the cab is reversed. The brake is applied to the wheel through a pressure of the right foot; the electric current is then interrupted. The steering is done solely through the maneuver of a central hand wheel placed in front of the coachman. The management of the vehicle is very easy and simple. Out of fifteen coachmen selected, twelve, after two days' practice, were capable of running the cab. While at rest, the vehicle is kept locked, and it is impossible for anyone to set it in motion. The coachman has merely to put the keys in his pocket and leave the cab to itself.

The company that has introduced these electric cabs in London has not wished to produce its own electric energy, because, in the first place, the price charged per day by the electric companies is sufficiently low, and, in the second place, because the service, upon increasing, would necessitate charging stations throughout the entire city of London.

The first charging station has been established on Juxon Street, Lambeth. The alternating current is furnished by the London Electric Supply Corporation at 2,400 volts and at a frequency of 83 periods per second. There have been installed two transformers, each composed of a Thomson-Houston alternating current motor directly actuating a continuous current dynamo of 75 kilowatts of the same manufacturers.

Fig. 2 gives a general view of the installation of the two transformers. The transformation of the electric energy of high tension with alternating currents into energy of low tension with continuous currents is effected with a rendering of 86 per cent.

Fig. 3 gives a view of the cab depot and Fig. 4 a view of the charging hall. The accumulator boxes have been taken from beneath the cabs, placed upon trucks and arranged along the walls in order to be recharged. The cost of the electric energy is three cents per kilowatt hour. With a complete charge, the cab is capable of making a trip of 48 miles, at an expense of fifty cents.—La Nature.

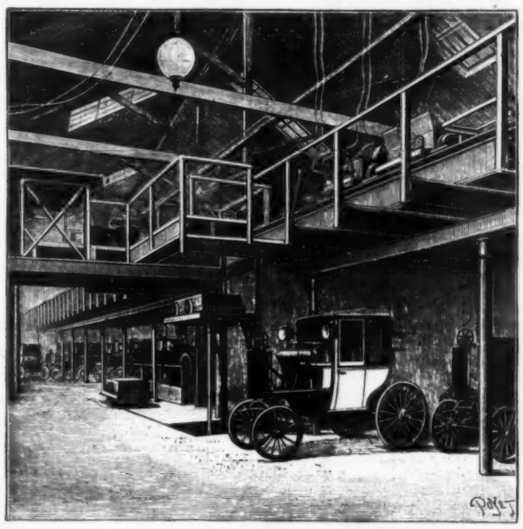


FIG. 3.—CAB DEPOT.

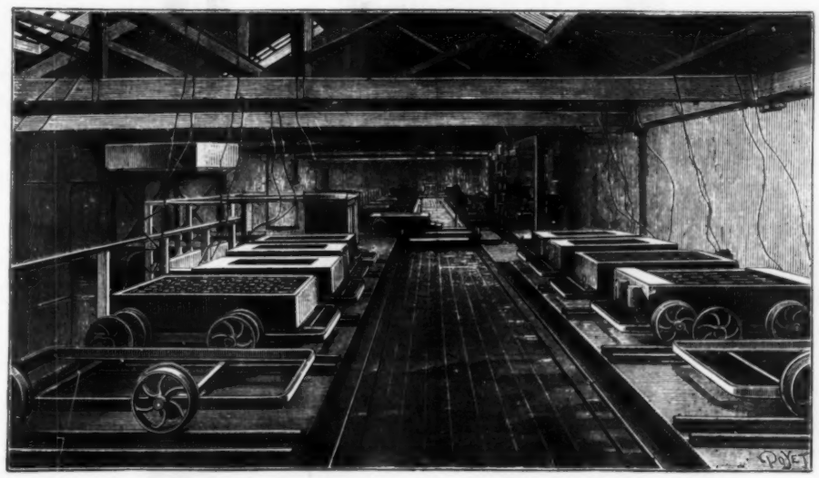


FIG. 4.—HALL IN WHICH THE ACCUMULATORS ARE CHARGED.

THE REFRACTIVE INDEX AND REFLECTING POWER OF WATER AND ALCOHOL FOR ELECTRICAL WAVES.

THE electro-magnetic theory of light, as originally given by Maxwell, included only the optics of a single wave length, and required extension to justify and harmonize the facts of selective absorption and dispersion. This extension was made by Helmholtz. According to him, a change in the refractive index with the wave length is to be expected throughout the complete spectrum; but, beyond a certain wave length, these values approximate rapidly to a fixed limiting value, so that the index may be regarded as practically constant for longer waves. The period of this characteristic wave length is theoretically of the same magnitude as that of the slowest possible vibration of the molecule, but it is practically unknown. Yet recent researches render it probable that this close approximation to a constant limiting value is exhibited by wave lengths much smaller than all electrical waves thus far produced. It seems probable that the great change in the value of the refractive index occurs in a part of the spectrum much nearer light waves than the Hertz oscillations. Still, the researches of Gratz and Fomm (Wiedermann's Annalen, 1895) and of Drude (P. Drude, Wiedermann's Annalen, 1895) indicate a certain amount of dispersion, even for long electrical waves.

It seemed desirable, therefore, to investigate the refractive index of these substances, particularly of water and alcohol, to see if it is the same for very short electrical waves as for long ones. The work was consequently undertaken by A. D. Cole, in Prof. Warburg's laboratory, and partly under the guidance of Dr. Rubens, of the Berlin University. The paper describing the investigation is given in full in Wiedermann's Annalen der Physik und Chemie, 1896. It will scarcely suit our purpose to follow the author through the details of his work, and his minute description of the apparatus employed: we therefore simply notice that he investigates: 1. The velocity of long electrical waves in water and alcohol by the method of E. Cohn. 2. Refractive index for short electrical oscillations. 3. Reflecting power of a metal for electrical waves. 4. Reflection of electrical oscillations by liquid surfaces. The paper is illustrated by diagrams of the apparatus employed and by tables. Summarizing all the results, we find that: 1. For oscillations of 300 cm. to 600 cm. total wave length, the refractive index for water is 8·95, for alcohol 5·20. 2. For oscillations of 5 cm. wave length two Fresnel formulas give the same value for the refractive index from observations of energy reflected at 45 deg. For water this value is 8·85, for alcohol 3·2. 3. The refractive index of alcohol is decidedly greater for long than for short electrical oscillations. Clearly the research is not yet concluded. We understand, however, that the work will be resumed shortly.—Electrical Review, London.

The cylindrical car is in evidence again, this time on the electric railway at Concord, N. H. It is also a convertible car, built on the principle of a rolling top desk, the side panels sliding up grooved posts into the roof to form an open-sided summer car. In case of a rainstorm or sudden change of weather the sides can be promptly rolled down. There are transverse seats and a central gangway.

APPARATUS FOR THE STERILIZATION AND FILTRATION OF WATER.

In the matter of treating potable and industrial water, France was represented at the Brussels Exposition by the apparatus of the Delhotel system, to which Messrs. E. Fourey, Sons & Company, the manufacturers, have given the most practical form.

In all the installations in which the Delhotel & Moride filter is used for furnishing sterilized and filtered water the reagent employed is alum, which, mixed with the water in the mean proportion of four grains to the quart, frees it from its pathogenic germs. Alum not only exerts a physical action, but also destroys the vitality of the biological elements.

M. Lacour, in his remarkable researches upon the sterilization of water, has even succeeded in sterilizing filters with alum or with alcohol, which he finds preferable to heat, which, without being any surer, is more costly.

The reaction is very simple. In the presence of the carbonate of lime that almost all water contains, there forms a subsulphate of alumina insoluble in water, and sulphate of lime and sulphate of potash in infinitesimal proportion remain dissolved, and carbonic acid is disengaged. It is the subsulphate of alumina that is the sole active agent. It brings about the formation of a lake that envelops the organic and mineral substances in suspension.

In order that it may be rendered potable, water thus treated requires more than a decantation. Simple rest, even for a long time, does not suffice to free it from its mucilage, and filtration is necessary after the treatment.

There are two cases to be considered: It is possible to establish a reservoir of impure water of a determinate capacity placed above a filter which delivers the pure water to a second receptacle situated at a lower level. Into the reservoir of impure water is put the desired proportion of alum, previously dissolved in a small quantity of warm water. After this has been shaken for a few minutes, it is allowed to rest for a quarter of an hour before filtration.

Such an installation is somewhat cumbersome. Since, in reality, the chemical reaction is immediate, it is possible to establish an automatic distributer of the reagent upon the filter itself, provided that the latter be capable of freeing the water from the mucilage that envelops the micro-organisms. Now, both experiment and practice have shown that the Delhotel & Moride filter fully satisfies this condition without the gelatinous substance of the precipitate proving an obstacle to the normal operation, since the cleaning may be easily done while the apparatus is at work.

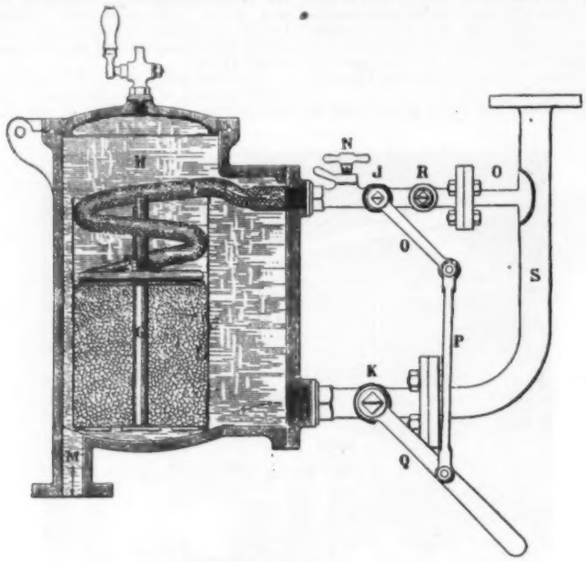


Fig. 1.—REAGENT DISTRIBUTER.

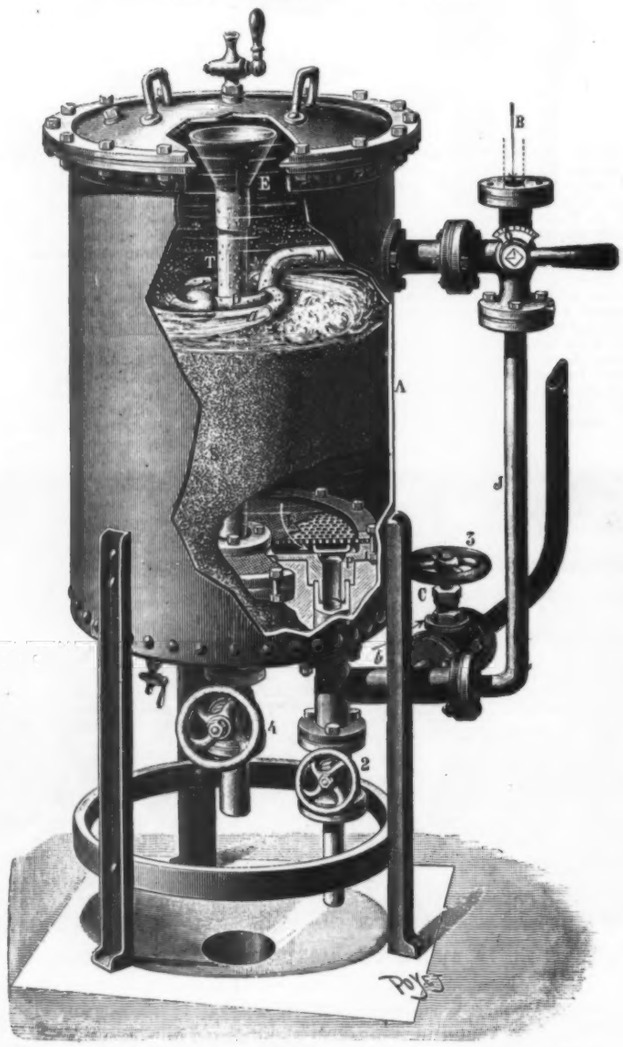


Fig. 2.—DELHOTEL & MORIDE FILTERING APPARATUS.

In the first description of the apparatus that we gave, an automatic distributer of the reagent was described. The one that we represent herewith is recent. In a cast iron receptacle, H, resistant to pressure and easily opened, there is a charging bucket, I, containing crystallized alum. All the impure water to be purified enters through the conduit, S. A small portion of the current passes through the cock, J, of the pipe, O, circulates over the alum and dissolves some of it. The largest discharge takes place through the cock, K, and mixes with the alumenized water in the conduit, M, ending at the filter.

The two cocks, J and K, are connected with each other through the cranks, Q, and the rod, P, which permit of regulating their respective discharges and of rendering their closing simultaneous. Besides, a cock, N, permits of perfecting the regulation of the water to be alumenized, which, through a conduit, L, is distributed by means of a perforated metallic pipe over the entire surface of the reagent and descends along the guide, G, in measure as the alum dissolves.

These cocks, having been regulated once for all, are registered. In this way there is obtained automatically, and without the necessity of any surveillance, a quantity of reagent proportional to the quantity of water to be treated.

A cock, R, interposed in the conduit, O, permits of the washing of the distributer with impure water. The distributer is charged for an operation of twenty-four hours at a minimum, and sometimes of seven days.

We shall now describe the arrangement of the Delhotel & Moride filter figured herewith.

This apparatus consists of an iron plate cylinder, A, capable of withstanding a pressure of five atmospheres, and in which there is a filtering mass, S, formed of finely pulverized silex. The water enters through the conduit, B, and the cock, 1, an annular tube, D, whence it makes its exit through four circumferential ajutages, a, having the form of an eolipyle. It traverses the sand, the collector, F, the tubulure, P, and the pipe, b, and makes its exit, filtered, through the conduit, C.

The collector consists of a cast iron disk supported by two squares riveted to the cylinder and upon which rests a perforated plate covered with fine wire gauze. Iron rings hold these different pieces by means of bolts and permit of easily changing the wire gauze. The disk, at its lower part, carries a tubulure, P, which, through friction, enters the corresponding tubulure of the conduit, b. The joint is formed with hackled flax or hemp or asbestos fiber.

In the interior of the collector there is a U-shaped piece which distributes the water introduced by the opposite current employed for the rapid cleaning, and which supports the perforated plate.

At the top of the central pipe, T, bolted to the bottom of the filter, there is mounted, through friction, a funnel, E, while below it is prolonged by a tube, of which the cock, 4, serves for the removal of the mud. By opening and closing this cock rapidly, it is possible, during the operation of the apparatus, to keep the surface of the sand clean. The water whirls rapidly upon its exit from the orifice of the ajutages of the eolipyle, and rises and drives the mud into the funnel, E, whence it flows to the exterior through the cock, 4. When it is desired to proceed with the complete cleaning of the filter, a counter current of water is employed. To this effect, the threeway cock, 1, is so maneuvered as to send the impure water into the conduit, J, and the cock, 3, for the filtered water is closed. The non-treated water enters the apparatus through the tubulure, b, flows under U, which distributes it through the collector, lifts the sand and washes it, and carries the impurities into the funnel, E.

In order to finish a washing through an opposite current, it is not necessary to wait for the water to make its exit, clear, through the cock, 4, since it can be arrested in a few minutes. The cock, 1, is then turned in such a way as to send the water upon the sand. Since at this moment the filtered water would pass in a turbid state for from one to ten minutes, the mud cock, 2, is opened so as to allow such water to flow to the sewer. When the water runs clear, this cock is closed, and the cock, 3, is opened in order that the normal operation may be resumed.

According to the pressure of the water disposable, the regulation of the opening of the cock, 1, is effected once for all, both for the sending of the water into the filter and for the washing. A graduation by index renders the registerings easy. If the filter should operate under too strong a pressure, as a consequence of a too wide an opening of this cock, the discharge would be too great, to the detriment of the clarification. As for the washing during the operation of the apparatus, too strong an opposite current might lift the sand to such a height that it would overflow into the funnel, while it should remain at a few fractions of an inch from the latter.

At the bottom of the apparatus there is a cock, protected against contact with the sand by fine wire gauze and serving for the complete discharge of the water in case the filter should have to be left for some time at rest.

Upon the cover there is a screw plug as well as a cock to allow of the exit of air.

The essential advantage of this apparatus consists in the facility with which it is possible, in less than a minute, to rid the filtering surface of its mucilaginous deposit. So it permits of successfully treating water that is very muddy or that is charged with chemical precipitates, without the necessity of having frequent recourse to cleaning by an opposite current.

No mechanical part involving any expense for manual labor or maintenance enters into the construction of this apparatus.

From the experiments made at the municipal laboratory of Paris, it results that the addition of a small quantity of sulphate of alumina to the water of the Seine (1-40,000th or 1-20,000th) and a passage thereof through the filter under consideration, permit, with a

large discharge under a limited volume, of clarifying this water perfectly, of freeing it from the greater part of its taste and odor, of removing, at a minimum, 90 per cent. of the bacteria and of eliminating from ¼ to ½ per cent. of the organic matter without changing the hygrometric degree or sensibly modifying the proportion of the weights of sulphate and carbonate of lime contained in the water.

The sulphate of alumina added to the water is, moreover, entirely precipitated in the state of subsulphate, and there remains no trace of it in the purified water. —Revue Industrielle.

THE NOSE AND RESPIRATION.

IN the physical study of respiration it seems that authors formerly directed their researches only to the organs situated below the neck; in other words, all of them neglected the important study of the respiratory orifice. It seemed indifferent whether one breathed through the nose or the mouth or through both simultaneously. But within the last twenty years a new branch of medicine has been instituted, that of rhinology, the object of which is the study of affections of the nose. This specialty, the beginning of which was modest, soon established the conception that affections of the nose are not only the local diseases that they seem to be, but that they have constantly a reflex action upon the general health. In fact, children whose noses are chronically obstructed develop poorly and remain sickly. Adults who cannot breathe through the nose become asthmatic and cannot withstand prolonged exertion. Moreover, there is a notion prevalent that in order that a person may run well, the mouth must be closed and the breathing be done through the nose. Finally, we know that the victors in different sports are never those whose noses

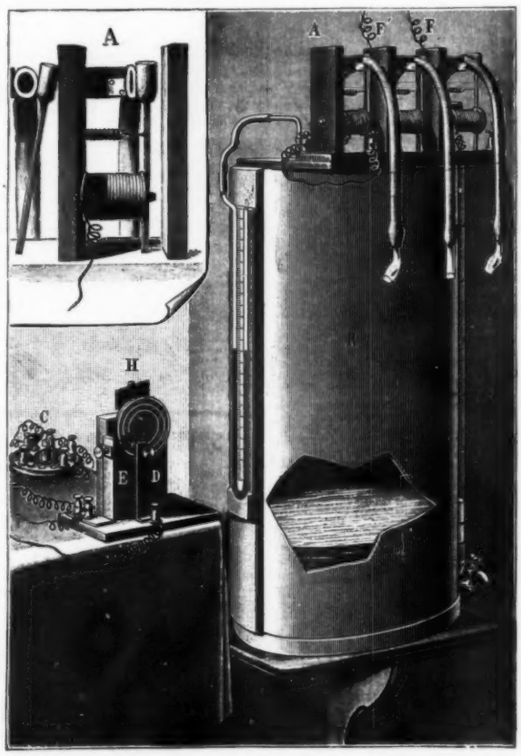


FIG. 1.—DR. MENDEL'S RHINOMETER.

are obstructed. A series of researches recently published* permits of giving a simple explanation of all these facts, which are quite different in appearance. We have been able, in fact, to prove, by means of the processes indicated further along, that the nose is the natural organ of respiration, especially because it is so arranged as to allow of the passage, for a given time and for a given inspiratory effect, of a larger quantity of air than the mouth. In other words, the buccal orifice standing for 1, the normal nose should stand for about 1·25. It will be at once seen to what a loss of air one is exposed by an inspiration that is exclusively buccal or that is effected through a nose of reduced capacity —a case of exceedingly frequent occurrence. Such an assertion may seem paradoxical. In fact, in order to respire with full lungs, do we not open the mouth widely? and have we not thus a sensation of inhaling a larger volume of air? At this moment, the inspiration is quite ample, but such inspiration is exceptional, since it constitutes an effort that we cannot constantly repeat. On another hand, in such effort, the nose and mouth inhale conjointly. The fact must also be taken into account that, although in this effort or in yawning the mouth is opened to a maximum, the same is not the case in ordinary respiration, in which the mouth is only partly open and constitutes a narrow orifice, a transverse slit limited by the slightly parted upper and lower teeth.

An organic arrangement further explains the superiority of the nasal orifice. We know, in fact, that the two nasal fossæ are placed side by side and that their posterior orifice (which is wider than the anterior) debouches in a spacious cavity—the pharynx. The latter, from the standpoint of respiration, extends from the base of the cranium to the glottic orifice, through which the inspired air enters the chest. The accompanying diagram (Fig. 2) shows the general arrangement of these parts.

The air drawn in by thoracic dilatation passes through the nasal fossæ and enters the pharynx. Now, upon comparing the sections of the different orifices, we find that the air flows through the nasal conduits in a quantity nearly double that which is capable of passing in the same time through the glottis; whence we may conclude that such air undergoes in the pharyngeal cavity a certain compression designed to facilitate the entrance of the air into the chest. But this cavity is not inert, it possesses muscular walls which execute rhythmic motions synchronous with the respiratory ones and which were discovered twenty years ago by Garland, of Boston. These pharyngeal motions, the interpretation of which has remained obscure, seem merely designed to quicken the circulation of the air in the pharynx and to aid the thoracic effort.

It will be seen from this diagram that the pharyngeal apparatus is adapted to the nasal orifice and that the buccal orifice does not benefit by it. It is found, besides, that the nasal passage, in its entirety, proceeds by slight curves, while the buccal conduit is placed at right angles upon the glottis; and how prejudicial to the flow of a fluid an angular arrangement proves is well known. Let us add that the presence of the epiglottis constitutes also an obstacle to the buccal inspiratory current of air.

However, the preceding views, which are somewhat theoretical, required to be sanctioned by experiment.

In the first place, we may put before the reader's eyes an analysis of a series of respirations obtained by pneumographic inscription. The two tracings shown in Figs. 3 and 4 were furnished by the same subject, whose nose was nearly normal. The one to the left represents the nasal respiration of the subject (the mouth closed) and that to the right exhibits his exclusively buccal respiration (the nose obstructed).

These tracings were inscribed upon a disk having a uniform circular motion from right to left. Each respiration is figured by an angle with its apex directed toward the center. The inspiration is represented by the right side and the expiration by the left, when the apex of the angle is placed above. It will be distinctly seen that each angle is separated from the following one by a circular line, the time of repose at which the inscribing style remained immovable. The amplitude of every respiratory motion is shown by the absolute length of the tracing and its duration by the arc that it occupies.

It may be seen from an examination of these figures that the subject made in the same time a larger number of buccal than nasal inspirations—a proof that each of the former gave him less air. But we remark, too, that each of these less rich buccal inspirations is more ample and of shorter duration. We must conclude therefrom that in such cases the chest expands more widely for inhaling air, but that such amplification is of short duration, precisely on account of the effort that the subject has to make in order to expand his chest in breathing through the mouth. The upshot is that to such thoracic effort, the duration of which is short, corresponds only the introduction of a relatively small quantity of air.

Another proof of our opinion is furnished by our rhinometer, an apparatus by means of which it is possible to determine with precision the degree of the nasal respiration of a subject. We have here one of the most useful of determinations in practice, since a normal nose is rare in man, and, in order clearly to appreciate the degree of permeability of this organ, one has been content up to the present with a simple inspection. The rhinometer consists essentially of a receptacle, R, the capacity of which is known. A variable quantity of water may be introduced into this receptacle in order to diminish its capacity for air. A water level permits of knowing the quantity of water introduced. A sulphuric acid pressure gage is adapted to the receptacle, with which it is connected by a rubber tube. Three other tubes (the central one of which is provided with a mouthpiece and the two others with nosepieces) open in the apparatus.

The rhinometric test consists in causing the subject to make two inspirations—one through the mouth, with the nose closed, and the other through the two nostrils, with the mouth closed. The tubes not employed being closed, each inspiration produces in the receptacle a vacuum, the degree of which is shown by the displacement of the pressure gage column. Upon applying Mariotte's law, it is possible, through the change of pressure, to ascertain the volume of air inhaled at each inspiration. More simply, the pressure gage degree gives us the value of each orifice. To us, the nasal value of a subject is represented by the formula

$$\frac{N}{B}$$

where N is the value of the nasal orifice and B that of the buccal. We have adopted the value B for unity because the buccal conformation is invariable, while the configuration of the nasal fossæ is rarely normal.

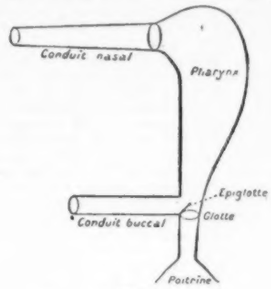


FIG. 2.

But, in order that the two different inspirations may be comparable, it is necessary (a) that they shall be effected with the same thoracic effort, and (b) that they shall be of equal duration.

In order to fufill the first condition, we recommend to the subject to inspire with his maximum effort. We have thus greater chances of obtaining two efforts that are sensibly equal. The second condition is obtained through a special arrangement.

The apparatus, A, the details of which are represented in the corner of Fig. 1, consists of three electromagnets provided with hammers designed to flatten the three rubber tubes, and which are actuated by the clockwork, H, the operation of which is as follows:

Upon an ebonite disk having a uniform circular motion are fixed three concentric metallic circles interrupted according to unequal arcs. A contact, D, may be adapted to any one of these three circles, the interruptions of which are so calculated as to represent one second, half a second and three-quarters of a second. While the disk is in motion and the contact is touching the metallic circle, the current passes, the electromagnet operates, the tube is flattened and inspiration becomes impossible. When the contact touches the interruption, the current no longer passes, the tube opens, and inspiration is possible, but in a time accurately calculated.

A commutator, C, permits of causing the operation either of the middle electromagnet alone on the buccal inspiration or the two lateral electromagnets simultaneously in the binasal inspiration.

Finally, a second contact, E, in relation with the circumference of the disk, actuates, through wires, F and F', an alarm that warns the subject that he must inspire. This system produces three light bell strokes a quarter of a second before the opening of the tube. With a little practice, the subject makes the beginning of his inspiration coincide with the opening of the tube.

FIG. 3. FIG. 4.

FIG. 3.—Tracing of Nasal Inspiration (duration of the rotation of the disk, 26 seconds). I, inspiration; E, expiration; R, rest. FIG. 4.—Tracing of Buccal Inspiration (duration of the rotation of the disk, 26 seconds).

With this apparatus we have been able to determine the nasal value of a large number of subjects. There are very few that have reached 1·25, which seems to us to be the normal value (the buccal orifice standing for 1). Such value often oscillates around 1, on account of the frequent diseases of the nasal fossæ, the result of which is to diminish the permeability of the nose and thus to limit the consumption of oxygen by the individual.—Dr. Mendel, in La Nature.

Non-Corroding Soldering Fluid.—The Iron and Coal Trades Review states that a reliable soldering fluid, free from rusting properties, may be made with four pounds of hydrochloric acid and about four pounds of ordinary zinc cuttings; if old zinc is used, a rather larger quantity will be required. It is best to add the zinc in two or three lots. When the acid is saturated—

* Physiologie et Pathologie de la Respiration nasale, par Dr. Mendel, 1897.

that is, when no more zinc can be dissolved—add a small quantity of oxide to color and filter through ordinary muslin. Having filtered, add one pound of strong liquid ammonia, stir and then bottle. This preparation can be used as a soldering fluid and will not cause rust to appear on the articles on which it is used.

AN ANCIENT GREEK HEALTH RESORT.

THE ancient Greeks, at all events after heroic times, were not always in the aggravatingly robust state of health that is the popular idea of their condition. Human nature is very much the same all the world over and at all times There were many health resorts where sufferers were treated by Asklepios himself, or more frequently by his qualified assistants, i. e., the priests, and the modus operandi at these institutions formed the subject of a very interesting lecture by Miss J. E. Harrison, recently delivered before the University Extension Society, says the London Lancet. The lecturer gave an account of what was perhaps the earliest known medical school, namely, that of the centaur Chiron. Here the children of the heroes were taught simple surgery, riding, gymnastics, the rudiments of music, and, in common with the ancient Persians, to speak the truth, the last being a branch of education which has fallen into disuse among both nations. The chief subject of the lecture was, however, the shrine at Epidauros, which has recently been excavated and is in fairly perfect condition. The temple and the long corridors where the patients slept are all there, but the holy well alluded to in many inscriptions has not been found. Besides these the patients have left memorials of their cures carved upon stones, a very full one being that of a Roman gentleman, and we are able, through the courtesy of Miss Harrison in supplying us with the original Greek, to append a translation. "I, Marcus Julius Apellas, of Idrias and Mylasa, was summoned by the god, as I suffered from a variety of complaints, and especially dyspepsia; and as I was on my way through Aegina he ordered me not to worry so much about myself (*μὴ πολλὰ ὀργίζεσθαι*). When I arrived at the shrine, he told me to go about for two days with my head covered up, and these two days it rained. He also prescribed for me cheese and bread with celery and lettuce, to wash myself by myself—i. e., without the help of the shampooer—to drink lemonade made from citrons, to go to the fountains in the baths and rub myself against the wall, to run and do gymnastics, to walk in the portico, and to exercise on the trapeze, to rub myself in the sand and go barefoot. Also before I went into the bath I was to pour some wine into the warm water; I was to shampoo myself, but all the same I had to give an attic to the bath man. I was to sacrifice to Asklepios, Epione and the Eleusinian goddesses, and to drink milk mixed with honey. And one day when I was drinking milk alone he said, 'Put honey in your milk and you will get the bowels open.' And when I implored the god to make me well quickly so that I could get home, I had a vision in which he ordered me to rub my body all over with mustard and salt, and I seemed to go down to the springs by the shrine, and a boy went before me with a smoking censer, and the priest said to me, 'Now you are well and you must pay your fees.' So I did as the vision directed, and when I rubbed in the mustard and salt it hurt, but when I washed it off it did not hurt any more, and this happened on the ninth day after I came, and he touched me on the right hand and on the breast. And the day after, as I was sacrificing, the flame leaped up and burnt my hand so that a blister came up, but my hand soon got well. And as I stayed on there he told me that anise and oil were good for a headache. I had no headache then, but some time afterward when I had been studying I had a headache, and I used the anise and oil and the headache disappeared. He also told me to gargle my uvula with cold water (for I had consulted him on this point too), and the same treatment for the tonsils. And he told me to write all these matters down, and so, grateful and restored to health, I went away." The naïveté of this narrative is delightful, but the treatment is eminently practical. Apellas is very like the ordinary patient—the sort, we mean, who, having paid his fee, says, "Oh, by the bye, there's one thing more I want to ask you. I often have," etc.

THE LIGHT OF FIREFLIES.

IN experiments on the properties of the light of fireflies, Prof. H. Muraoka used plates of copper, aluminum, zinc, and brass of equal size, separated from the photographic plates on which they were severally laid by a layer of cardboard having a cross shaped piece cut out of the center; wrapped the whole with three or four thicknesses of black paper, and exposed the bundle to the light of several hundred fireflies. His purpose, says The Popular Science Monthly, was to learn whether the light from the insects after filtration through the black paper could penetrate the metals and affect the photographic plate, and to determine the relative transparency of the substances used. To his surprise, the parts of the photographic plate under the cardboard were most darkened, while those under the cross shaped holes remained clear. The light of the insects seemed to behave very much like ordinary light, but, after "filtration," acquired properties similar to those of the Roentgen or the Becquerel fluorescent rays—properties apparently resulting from the filtration. Further, the filtered rays appeared to exert a peculiar action toward the cardboard—called by the author a suction phenomenon—similar to that of the lines of magnetic force upon iron. The properties of the filtered rays seemed to depend on the filtering substances, probably upon their thickness. They exhibited properties of reflection, but those of refraction, interference and polarization were not observed, although the author believes that they exist. Their properties, generally, appear to be between those of the ultraviolet and the Roentgen rays. The insects used in the experiments had two or three rows of luminous spots on their under-body; but the photographic plates were affected by the whole body as well as by the luminous spots, so that a complete image of the insect was formed when it was put upon the plate, the figure of the luminous part being, however, plainer than the rest.

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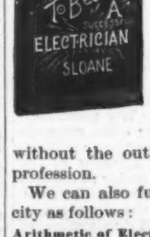

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